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ABSTRACT

Based on the idea that the prevention and treatment of water pollution should begin at its source, this document focuses on some methods that individuals can use in their homes and businesses to treat wastewater. Chapter one, "What Is the Water Crisis?" explains the basic concepts of the hydrologic cycle, evapotranspiration, and the quantity of water available. The discussion focuses on how much water North Americans use, ways that water becomes contaminated, and some efforts underway to improve water quality. Chapter two, "Clean Water Begins at Home," stresses the cultural context of waste disposal, discusses how much waste is produced by humans and advocates water conservation. Chapter three, "What to Do with Body Products," compares on-site and off-site treatment, as well as dry versus water-based treatment. Chapters four, five, and six are concerned with commercial dry treatment systems, owner-built dry treatment systems, and greywater restoration systems. Chapter seven, "Saving Water and Money," describes common water conservation devices and tips, and provides information on various commercial low-flush toilets. Chapter eight, "Water Lessons That Travel," provides short case studies about communities that have implemented water conservation measures, and an historic account of various water-related events. Illustrations are included. Lists of suggested readings and organizations are provided. (TW)

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WE ALL LIVE DOWNSTREAM

A Guide to Waste Treatment
That Stops Water Pollution.

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THE NATIONAL WATER
CENTER

Eureka Springs, Arkansas

By Pat Costner
with Holly Gettings and Glenna Booth

SE 048154

WE ALL LIVE DOWNSTREAM

For Everyone Who Wants Clean Water . . .
A Guide to Waste Treatment
That Stops Water Pollution.

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with Glenna Booth and Holly Gettings

The Water Center

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To Ella

and

**to all of the waterworkers who came before us and those who will
come after.**

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The Water Center is indebted to our friends and neighbors who have supported us faithfully and to the Threshold Foundation for their generosity.

Foreword

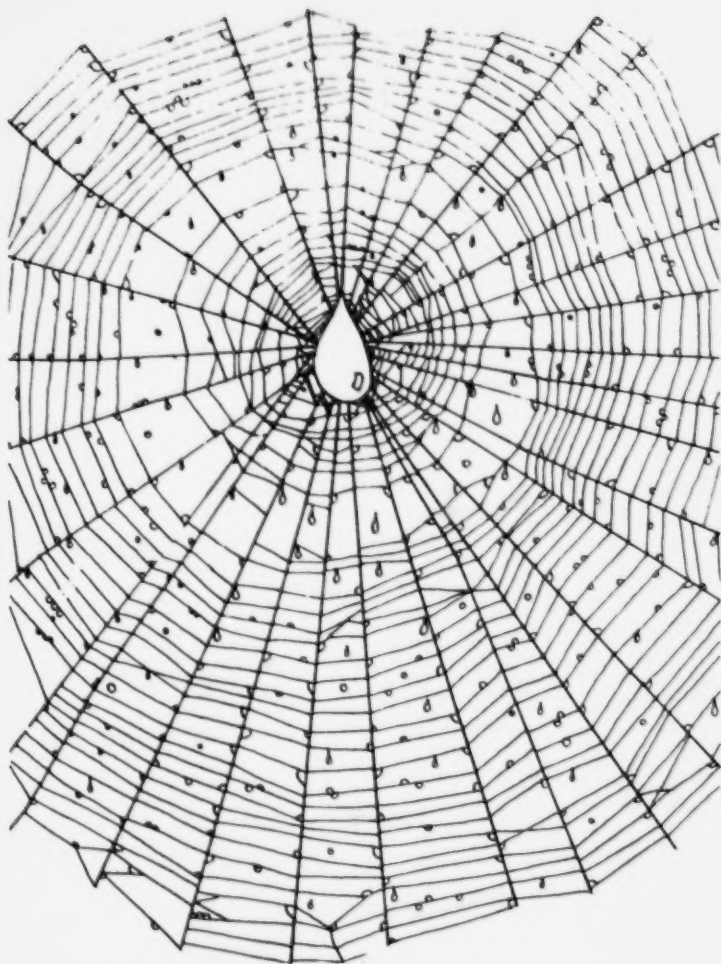
The most important issues of our time are water and peace. Both are survival issues. Both require that we learn to live thoughtfully and cooperate with each other . . . forever.

Every action we take — whether in the political, social, economic or environmental sphere — affects and is affected by the water.

Impact on water resources is the bottom line in every potential environmental problem — the fate of industrial and personal wastes, pesticide/herbicide use, acid rain, farming methods, forest management, oil exploration and drilling, mining practices, urban development, . . . even nuclear war.

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Water is a simple stuff
You find it everywhere
As ice or steam or
Flowing in a stream
As snow or
Raining through the air
As balls of hail
As sheets of sleet
As soft as a field of fog
Water is a magic web
In which all of Life is caught

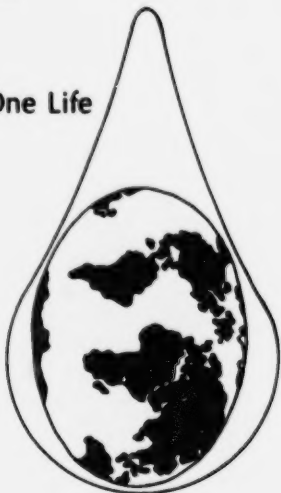
MUMS THE WORD

© By Evi Seidman

One World. . .One Water. . .One Life

The Earth is one planet
and its water is one water,
flowing on, over and through the Earth
... and all of its living creatures.
In its flow, the water joins
each one of us to the other.

One World . . . One Water . . . One Life



We All Live Downstream

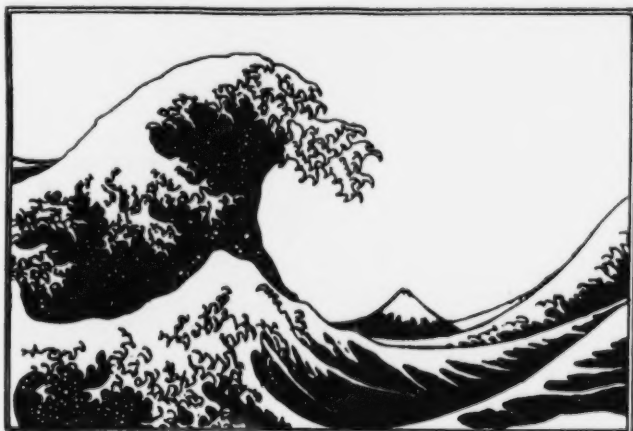
The title of this book, *We All Live Downstream*, is more than a slogan. It is a guideline for living. For each one of us, clean water is a need, and clean water is a right. To meet this vital need and to protect this basic right, we must keep our commonly held water resources free of ALL of our products, both wanted goods and unwanted wastes.



Good Water . . . Good Life

Life and water are inseparable. Water is the one substance that is common to every creature on the planet. The quality of life in every watershed, community and home rests ultimately with the quality of the water.

Only one hundred years ago, North America's most abundant natural resource was clean water. Fifty years ago most of the continent's rivers, lakes, aquifers and coastal waters were still filled with water of high quality.



Today these water resources are a soup of chemicals and nutrients. Unwanted products pour from industries, cities, agribusinesses, and homes. They leak from waste ponds, landfills and injection wells. And they rain from smokestacks and incinerators.

Clean water for fishing and swimming is a vanishing luxury, available only to those who can afford to find it.

Clean water for drinking is an industrial product, bought and sold by the gallon.



Clean Water – Zero Wastes

During the early 1970's, major legislative actions were taken to restore and protect U.S. water resources. With its "fishable and swimmable" goal for navigable waters, The Clean Water Act initiated the move toward zero waste discharge, where producers detoxify their own wastes, releasing clean water and useful materials.

This Act and its companions, such as the Safe Drinking Water Act and the Resource Conservation and Recovery Act, were a visionary effort to meet the nation's need for clean water. But the vision was flawed by the failure to include groundwater protection measures. And it was soon lost in a flood of regulations that first implemented and then impeded realization of the final goal.

These legislative attempts at water protection slowed, but did not stop, the deterioration of U.S. surface water. The massive fish kills of the 1960's gave way to the more subtle, but deadly, diseases caused by invisible toxic wastes. Left unprotected, groundwater pollution increased with growing reliance on landfills and injection wells for waste disposal. Water pollution has not been stopped; only the pattern has been changed.



The water crisis will not be stopped by playing a "shell game" with the wastes, putting them in one place and then in another. It is the nature of water to dissolve, mix and mingle. No matter where unwanted products are "disposed of" on the planet — landfills, injection wells, incinerators, or ocean dumps — the water will eventually carry these wastes or their residues into the food chain.

The water crisis will be stopped by the detoxification of wastes by their producers at their sources. The water crisis will come to an end when the wastes from factories, farms, businesses, cities and homes are processed into nutrients that can be safely assimilated into the soil-based food chain.

Clean Water Begins At Home

For the first time in history, water has become the sanitary convenience of an entire civilization. Using water as a personal waste vehicle — the repository for everyone's feces and urine — is a very recent cultural phenomenon. Only a few generations have been toilet trained to water, but this experience has profoundly distorted our collective sense of reality.

Water toilets reinforce one of our mightiest taboos, the social prohibitions that surround our body products. They let us forget that feces and urine are a natural part of the food chain — repayment to the soil for the nutrients supplied in our food. Water toilets foster the illusion that these or any other products can be flushed away without consequences.



In our culture, our most frequent and most commonly shared experience with water is with the water in a toilet bowl. This daily, lifelong practice fosters the illusion that water is little more than a handy receptacle and vehicle for unwanted products.

Today's water crisis is the logical consequence of this twofold "waste/water" illusion. Where water is a waste vehicle and anything can be a waste, no water resource is safe. Our culture is permeated with this "waste/water" illusion. It is instilled in one of the earliest and strongest lessons of childhood — toilet training. It is reflected in the design and operation of every conventional home, city, business, factory and farm.

Water resources will be clean when our culture gives full value to water and wastes. Values that reflect our absolute dependence on water for life and the reality that there are no wastes, only misplaced resources. Like all cultural values, these must be acquired in the home. The water crisis ends and clean water begins at home.

Chapter 1

What is the Water Crisis?

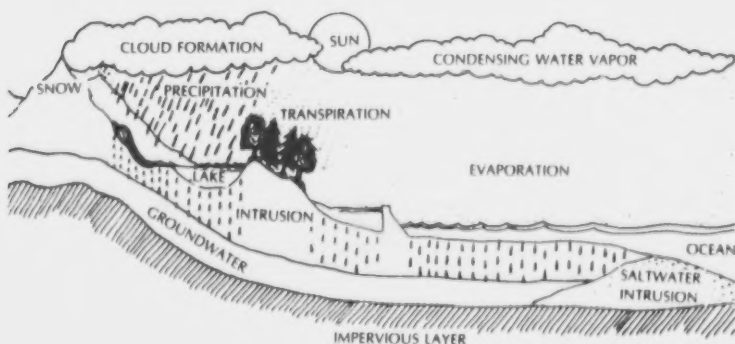
The water crisis is *not* a lack of water. It is the lack of *clean* water.

North Americans use a lot of water—about 700 billion gallons per day in the U.S., almost 3000 gallons per person per day.^{1,2} But North America has plenty of water. On an average day, rainfall feeds 1160 billion gallons of fresh water into U.S. surface waters, enough to supply 4800 gallons to each person every day.³ Fifty times this quantity of water lies in aquifers beneath the continent where some of it has been stored for millions of years.^{4,5}

There are occasional local droughts, but there is no water shortage. There is poor management — the result of misinformation, lack of information and, as some might say, a lack of common sense.

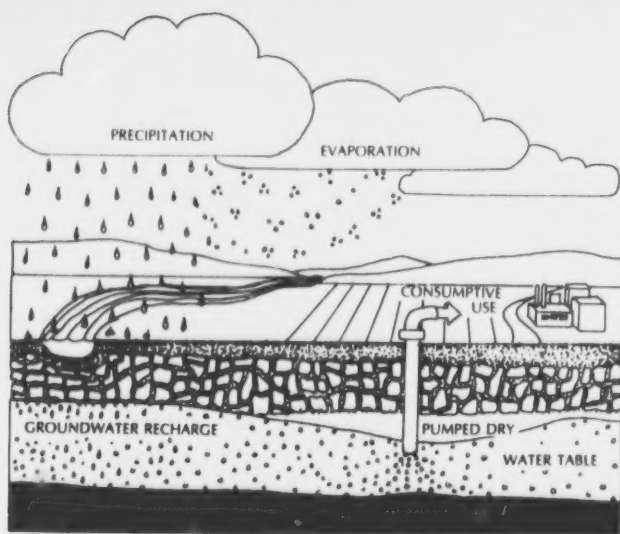
The water crisis is the loss of clean, healthful water. It is the degradation of life-base water resources with the products of people's bodies, homes, cities, factories and farms.

Water shapes North America. Its rivers, streams and lakes mold the continent into watersheds. Each watershed, like the continent as a whole, has its own limited supply of fresh water. By its quality and distribution, this water governs the quality and quantity of life that each watershed supports.



The people of a watershed also affect the quality and quantity of life there, largely through their impact on water resources. Using good management, they can live within their means, budgeting and safeguarding their finite water supply for the benefit of the entire watershed.

Without stringent protection, water resources will inevitably be over-drafted and polluted. The watershed's quality of life will deteriorate along with its water quality, as neighbors struggle among themselves over the dwindling supply of clean water. Legal, political and economic "water wars" are already common in many areas of North America — within watersheds, between watersheds, even between states and nations.



Water is life's most important nutrient. It has no substitute. There is plenty of water to nourish every species, but there is not enough to serve as people's personal and cultural toilets. Depositing the products of our bodies, homes, factories and farms in the water resources of our watersheds makes even less sense than using gold leaf as toilet paper. At least gold is not essential to life.

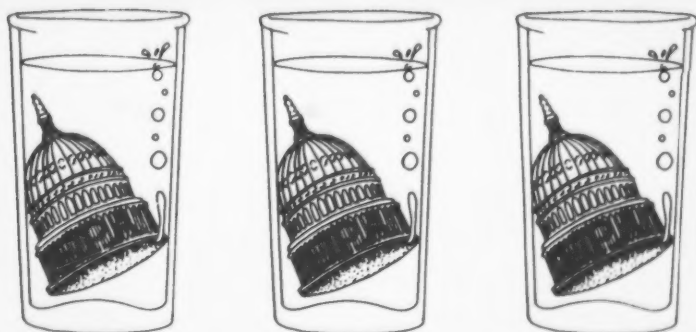
Of course, both gold and water can be cleaned. But, so far, we have been either unwilling or unable to restore the water used to carry our wastes. Since the technology for removing wastes from water is expensive and complex, we "treat" our wastewater to make it inoffensive, not clean. The polluted condition of our freeflowing water resources reflects the inadequacies of this "wastewater treatment."

The quality of our water resources is, in many ways, a measure of our maturity as individuals and as a culture. Until now, we have lived like children with the water nourishing us and cleaning up the messes we leave behind. But, like any parent, the water has its limits. We have met those limits in the water crisis. Today, it is time to grow up and clean up after ourselves.

Who Will Stop the Water Crisis?

The water crisis will *not* be stopped by the rules and regulations of governments. These institutions reflect cultural values; they do not mold them.

For the past 50 years, government agencies have been regulating, even subsidizing, the production, use and disposal of billions of tons of poisonous chemicals. Until World War II, such toxins were primarily confined to the laboratory. Today they are spread throughout the water resources, the food chain and the people. Even mothers' milk is not safe for their babies.⁶



Charged with overseeing more than 65,000 synthetic chemicals with as many as 1000 new additions each year,⁷ U.S. agencies are trying to estimate the maximum amount of each chemical that an average adult can tolerate without showing immediate symptoms of disease. So far, 248 of these potential poisons have been tested and 195 others are in the midst of the five to six year testing program.⁸

In the U.S., the Environmental Protection Agency sets the standards for "acceptable limits" of exposure to toxic chemicals by a "risk assessment analysis" that weighs the value of human life and health against the cost to industries for keeping their toxic products out of the environment.⁹ The so-called "acceptable limits" do not reflect the reality of chronic exposure to combinations of toxic chemicals.

In 1976, U.S. agribusinesses applied 1.6 billion pounds of pesticides, more than 8000 times the quantity used in 1950.¹⁰ In 1942, before these chemicals were commonplace, the pre-harvest crop loss to pests was 31.4 per cent. Today, after four decades of pesticides, the pre-harvest crop loss is 33 per cent.¹¹

In 1984, more than 280 million acres of U.S. cropland were treated with pesticides.¹² In Iowa, farmers have a 32 per cent greater risk of dying from cancer than non-farmers. In Nebraska, the rate of leukemia for farmers is 44 per cent greater than for non-farmers.¹³

In California, 57 different pesticides have been found in 3000 wells.¹⁴ On Long Island, excessive levels of aldicarb were found in over 2000 wells.¹⁵

Between 1981 and 1983, the production of hazardous wastes in the U.S. doubled, reaching 560-600 trillion pounds — over 2400 pounds per person.¹⁶

The U.S. General Accounting Office estimates that there are 378,000 hazardous wastes sites throughout the U.S.¹⁷ The EPA has cleaned up six of those 738 sites classified as high priority.¹⁸

The water crisis will be stopped by people in their homes, communities and watersheds as the awareness grows that protecting water resources is a *personal responsibility*. Our lives and livelihoods depend on keeping our products out of the water that flows through our watersheds, our homes.



Something Fishy's Going On

The connections between contaminated water resources and disease are growing clearer and clearer:

The water in 63 per cent of private wells, 20 per cent of community wells, and 28 per cent of municipal supplies in the U.S. is not safe to drink.¹⁹ In California, 25 per cent of the wells are contaminated by industrial chemicals or pesticides.²⁰ In Wisconsin, 17 per cent of the wells are chemically contaminated.²¹

In the Hudson River, the Black River and Puget Sound, some species of fish have liver cancer rates of 70-80 per cent.^{22,23,24} More than 800 chemicals have been found in the Great Lakes,²⁵ where carp have 100 per cent incidence of tumors of the reproductive system. Carp taken 30 years ago at the same sites had no tumors.²⁶

People who live in counties bordering the Great Lakes have higher rates of stomach and esophageal cancers than those residents in inland counties.²⁷

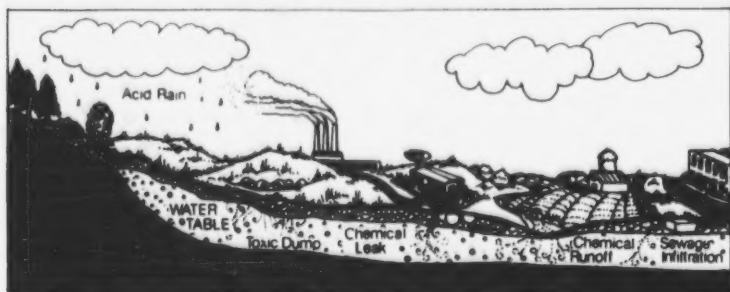
Faculty at the Smithsonian Institute have found correlations between maps showing areas with high incidences of fish tumors and those with areas having high cancer rates in humans.²⁸

In a landmark study in Woburn, Massachusetts, Harvard scientists demonstrated a clear link between chemically contaminated water and human diseases, including childhood leukemia, other forms of cancer and miscarriages.²⁹

Between 1929 and 1979, the sperm count of U.S. men dropped by 30 per cent, and is still declining. Nearly 25 per cent of American men are functionally sterile. Fertility problems are increasing for women, while the miscarriage rate has reached at least 25 per cent.³⁰

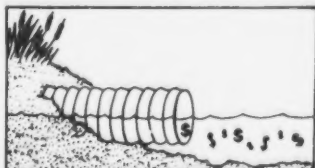
The Center for Disease Control reports show phenomenal increases in some birth defects. For instance, two types of heart deformities in newborn infants occurred 130-210 times as frequently in 1982-83 as in 1970-71.³¹

Cancer, heart and lung disease accounted for 12 per cent of deaths in 1900, 38 per cent in 1940 and 59 per cent in 1976.³² Government reports link 60-90 per cent of all types of cancer to synthetic chemicals³³



The time has come to change personal and cultural attitudes toward all of our products, those we market and those we try to throw away. Sooner or later, the water brings them back to us in our food chain.

Pouring Money Down the Drain



Between 1972 and 1985, more than \$45 billion in federal funds has been spent on municipal wastewater treatment systems.³⁴ Not one of these systems can remove all of the pollutants that have been put into the water by urban families, factories and businesses.

In fact, federal laws do not require that these wastewater treatment systems discharge clean, waste-free water. If the treated wastewater is cosmetically acceptable — relatively odorless and clear — it meets most federal standards. Yet, one-third of municipal systems are not even meeting these minimal requirements.³⁵

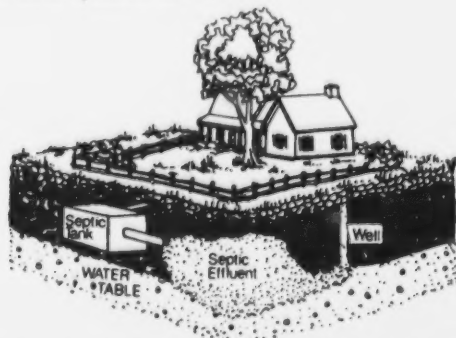
Every stream, river, lake or coastal area that is downstream from a municipal sewage plant is polluted. The treated wastewater that is discharged into these water resources normally carries viruses, bacteria and parasites. It carries the dissolved components of feces, urine, detergents and food scraps. And it carries synthetic chemicals: those discarded by households and industries; those added as part of the treatment process, and those produced by the treatment.³⁶ Even municipal sludge, the solid residue accumulated during the treatment process, often contains enough toxic chemicals and heavy metals to be classified as a hazardous waste. Buried in landfills, the sludge is a threat to groundwater. Applied to farmland, it can contaminate soil, crops and surface water.^{37,38,39}

Two-thirds of all U.S. homes are served by centralized wastewater treatment systems that discharge pollutants directly into the surface water. In virtually every such system, the underground pipes that carry wastewater to the treatment facility also leak raw sewage into the groundwater.

Out of Sight, But Not Out of the Water

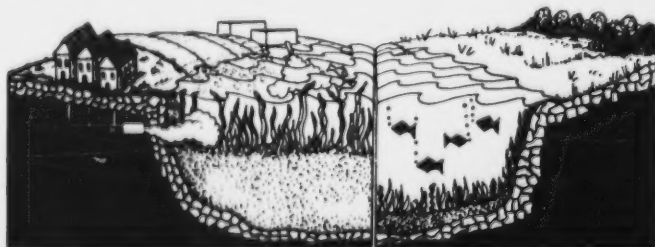
The remaining one-third of U.S. homes use individual septic tank systems which were first introduced in 1884.⁴⁰ In these, the wastewater flows into a tank, where solids settle out, then go into perforated pipes that are three to four feet beneath the surface. Trickling out into the sub-surface soil, the wastewater percolates down to the groundwater. Even when built and maintained according to government standards, these systems are a major source of groundwater pollution.⁴¹ Each year at least 800 billion gallons of wastewater pass through these systems into the groundwater, carrying bacteria, viruses, synthetic organic chemicals, metals, salts and the nutrients nitrogen and phosphorus.⁴²

Nitrogen and phosphorus from household wastes are valuable fertilizers when added to the soil. However, in water resources they are unwanted pollutants. In all types of soil, the groundwater beneath a standard septic tank/leach field will be contaminated by a plume of nitrogen in the form of nitrate.⁴³ Since all soils have a limited capacity for adsorbing phosphorus, groundwater pollution by this nutrient is inevitable where septic tank systems are used.



Infants who are given nitrate-rich water are known to develop methemoglobinemia, an oxygen deficiency syndrome.⁴⁴ In adults, nitrates may be converted to nitrites which have been linked to accelerated cancer rates.⁴⁵

When nutrient contaminated groundwater flows into rivers and lakes, it accelerates their "swampification", creating algae blooms, thick slime growth and abundant aquatic weeds. With these "green water" problems, over-fertilized rivers and eutrophic lakes lose their value as drinking water sources as well as for sports fishing, swimming and boating.⁴⁶



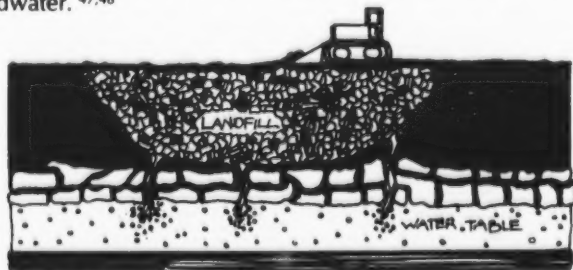
Years ago, when the basic designs for most wastewater systems were made, the primary goal was to separate people from their own excreta as quickly and thoroughly as possible. At the time, water resources were regarded as infinite, both in capacity and in the ability to cleanse themselves. So dilution and distance were the tools of the trade for wastewater engineers.

With today's increasing population and its water demands, this approach is profoundly inadequate. The water crisis points out the need for a new priority — protecting water resources. If water is to be used to carry our wastes, we must design wastewater treatment systems that can restore that water completely before it is returned to our water resources.

Can't Bury It!

Burying refuse from homes, cities and industries in the earth may keep it out of sight, but it does not keep it out of the water!

In scientific texts, water is often referred to as "the universal solvent", because it has such strong dissolving powers. So it is only natural that with every rain, water soaks down through landfills and dumps, leaching away an awesome array of toxic chemicals and heavy metals. Beneath 75 per cent of the landfills in the U.S., which cover more than 100,000,000 acres, this toxic leachate is polluting the groundwater.^{47,48}



In efforts to stop rainwater from percolating through buried wastes, clay caps are sometimes laid down over landfills. Clay and other materials are also used to line municipal and hazardous waste landfills to contain the wastes and trap any leachate.

Since many clays shrink as they dry, forming fissures, both clay caps and clay liners commonly leak in arid climates and during dry seasons.⁴⁹ Also both clay and other liner materials, such as polyvinyl chloride and other plastics, are often severely damaged by the waste materials and their leachates.^{50,51,52}

In cases where landfill caps have not yet leaked, the refuse has remained unchanged. After ten years, newspapers are still legible, grass clippings are still green and tin cans still unrusted.⁵³ So even leak-proof landfills are not true waste disposal. They are perpetual care burial for mummified garbage and still-toxic industrial wastes—millions of acres of refuse waiting to be detoxified and recycled.

By 1990, the annual production of municipal garbage in the U.S. is expected to reach 650-750 trillion pounds, more than 2000 pounds per person. Landfill leachate may indeed "exert a major environmental impact".⁵⁴

A Shot in the Dark

With increasing restrictions on direct discharge to water resources and public resistance to industrial landfills, more industrial wastes are being sent deeper beneath the earth. In 1984, an estimated 57 per cent of hazardous wastes in the U.S. were pumped down 525 deepwells. Use in 1986 is expected to double.⁵⁵ Deepwell injection is the real "shot in the dark" of hazardous waste burial. Once pumped deep in the earth, the wastes can and do travel in all directions. They follow geological fracture lines or are carried along by an aquifer until they surface in someone's drinking water. The 2,000,000 or more abandoned oil wells across the U.S. provide another easy route to the surface for injected wastes.⁵⁶

Groundwater contamination problems caused by injection wells have been so pervasive and catastrophic that Alabama and Florida have banned them.⁵⁷ Even major industries, such as Kerr-McGee and Dow have voluntarily given up this cheap and easy way to get rid of toxics because of its many problems.⁵⁸

Like landfills, injection wells are simply more perpetual care burial. Only the hazardous wastes will be more difficult, if not impossible, to retrieve for the detoxification that must eventually be carried out.

Can't Burn It!

In recent years, incineration has been hailed as the perfect solution to the mountains of municipal and industrial wastes. The wastes vanish into thin air leaving only an energy recovery bonus behind — on paper, perhaps, but not in reality.

At best, incinerating wastes converts them into air pollutants that fall back to surface water with the rain and a solid residue, fly ash, that requires special care because of its toxicity.



Recent studies point to municipal garbage incinerators as major sources of extremely toxic chemicals:

In Denmark, the National Environmental Agency estimates that municipal garbage incinerators are emitting over 70 pounds of dioxins and furans into that country's watersheds each year.⁵⁹

In Sweden, analyses of human milk are finding levels of dioxins and furans high enough to give nursing infants 10-100 times tolerable daily doses of these toxins. Municipal and industrial incinerators are the primary sources. Since these findings, the Swedish government has imposed a one year moratorium on new municipal waste incinerators.⁶⁰

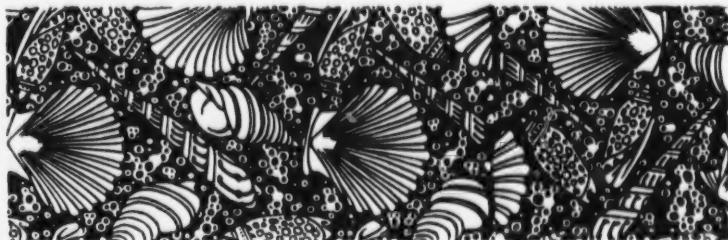
From one-third to one-half of the annual volume of liquid hazardous waste in the U.S. is burned in industrial boilers and similar facilities. In one survey, 43 per cent of these waste burners did not "come close to meeting incineration standards".⁶¹

Federal regulations for hazardous waste incinerators require a 99.99 per cent destruction efficiency for the chemical to be destroyed.⁶² On the ocean incinerator ship Vulcanus, polychlorinated biphenyls (PCBs) were destroyed at this 99.99 per cent rate, while tetrachlorodibenzofurans, another extremely toxic class of chemicals, were burned at a 99.9 per cent efficiency.⁶³

These results seem good, but are they good enough to protect the people who live downwind and downstream? If a commercial waste incinerator burns 20,000 gallons of dioxin-contaminated oils at 99.9999 per cent efficiency, enough unburned dioxin can be released to poison many people.⁶⁴

Dioxin is one of the most toxic substances known. At five parts per trillion, the equivalent of one ounce in six million tons, dioxin has caused at least six different types of cancer in laboratory animals. This same unimaginably tiny quantity kills fish and newborn mammals.⁶⁵

In addition to the undestroyed remnants of the major toxins to be incinerated, people in neighboring watersheds are exposed to new dangers — the toxic chemicals that are produced during the incineration process itself.⁶⁶ These new poisons are not regulated and often are not even identified.⁶⁷



How Will the Water Crisis Be Stopped?

The water crisis will *not* be stopped by continuing to play a "shell game" with our wastes, putting them first in one place and then another. There are simply too many of us and our products and by-products are too voluminous and too complex.

Whether we bury them in landfills, pump them down wells, flush them into rivers and oceans, or incinerate them, the water will eventually bring our products and by-products right back to us in the food we eat and the water we drink. This planet is one enormous recycling system. If we produce and release poisons, we end up eating and drinking poisons.

Depending on the current piecemeal approach of federal and state agencies to stop the water crisis is much like expecting seat belt laws to prevent automobile accidents. Driving habits and water use habits are ultimately matters of personal choice.

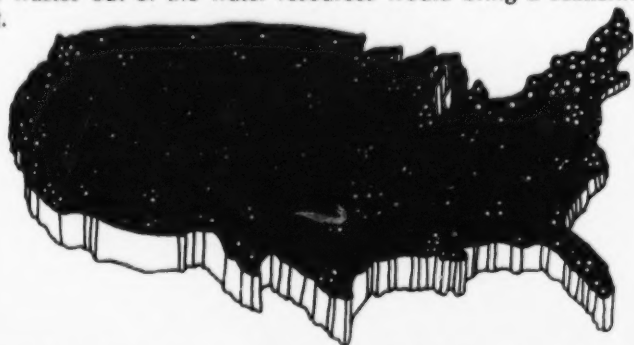
Historically, U.S. environmental laws have been reactionary — remedial responses to already existing problems, not preventative. But, by the primal, unchangeable roles and properties of water, protecting water resources requires prevention — forethought instead of hindsight.

In some countries, the groundwork for effective water resource protection is already being laid. In Holland, national law allows the government to prohibit the production of chemicals that cannot be detoxified.⁶⁸ In West Germany, over 30 per cent of the households are active in a voluntary program to separate garbage into recyclable components.⁶⁹

In many ways, the North American water crisis can be seen to be both cause and effect in the cultural transformation that is now in progress. Our society is finally having to leave its carefree adolescence behind, a time when life and resources seemed infinite. We are coming into adulthood with the recognition of reality and respect for physical limitations.

Like all cultural changes, this one is spreading from the grassroots level, among people who value life, their homes, communities, and their life-base water resources enough to take personal responsibility for their protection.

If the water crisis were mapped — a black dot for each contaminated water supply, every polluter, all the landfills, injection wells and incinerators — North America would be dark. But a pinhole for every individual, community, industry and farm that is working to keep their own wastes out of the water resources would bring a scattering of light.

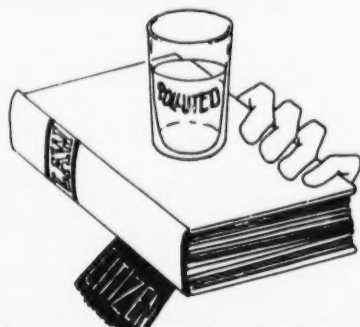


Clean Water - Zero Waste Discharge

There are many approaches to water resource protection, but *Zero Waste Discharge* is central to each one.⁷⁰ Achieving zero waste discharge does not mean throwing away all of our technological advances to crawl back into caves. It means coming full circle with that technology to take care of the problems it creates.

The scientists and engineers who create new products and design the processes for manufacturing them are the people who will bring industries to zero waste discharge. More than anyone else, an industry's own people are best qualified to take care of that industry's wastes by recycling, reducing, exchanging and detoxifying the by-products of its processes.

Between 1981 and 1983, the quantity of hazardous wastes generated by U.S. industries doubled, reaching 600 trillion pounds per year.⁷¹ With proper incentives, the industries which produced these wastes could have recycled and detoxified them. Instead, most of these toxins were left to endanger the general public and our water resources until it becomes necessary to contain or detoxify them at public expense. Establishing the requirement for zero waste discharge is the only way to insure producer responsibility and to protect water resources from midnight dumpers and transportation spills.



Many communities are setting up their own legal framework for keeping hazardous wastes out of their water. In Arkansas, Union County has passed an ordinance prohibiting the storage, treatment or disposal of hazardous wastes.^{72, 73} In 1982, Jacksonville, Florida passed an ordinance prohibiting the incineration of polychlorinated biphenyls. Meanwhile, in Chicksaw and Mobile, Alabama residents passed ordinances on hazardous waste transportation through their towns that were so restrictive that a commercial waste management company finally gave up and went elsewhere.⁷⁴

Residents of Fayetteville and Eureka Springs, Arkansas, enlisted the support of their city governments in seeking state approval for composters and greywater systems. These domestic waste treatment systems keep household wastes out of water resources by recycling them on-site — zero waste discharge for homes.^{75, 76}

Both cases are still pending. However, in anticipation of eventual approval, some urban households have installed these systems that are already available to rural homes.⁷⁷ Segregating domestic garbage for recycling is a common practice in homes, cities and counties across the continent.

Local Efforts

Local communities, counties and smaller watersheds are the most appropriate and most effective areas for zero waste discharge initiatives for water resource protection. Here is a general approach:

1. Conduct a waste audit of the area — mapping each producer, the quantities and components of their wastes, and each existing hazardous waste site such as lagoons, landfills, injection wells, incinerators and storage sites and transporters.

2. Enact ordinances prohibiting the discharge or disposal of hazardous wastes (solid, liquid or gaseous) within the city, county or watershed and restricting the transportation of such wastes through the area.

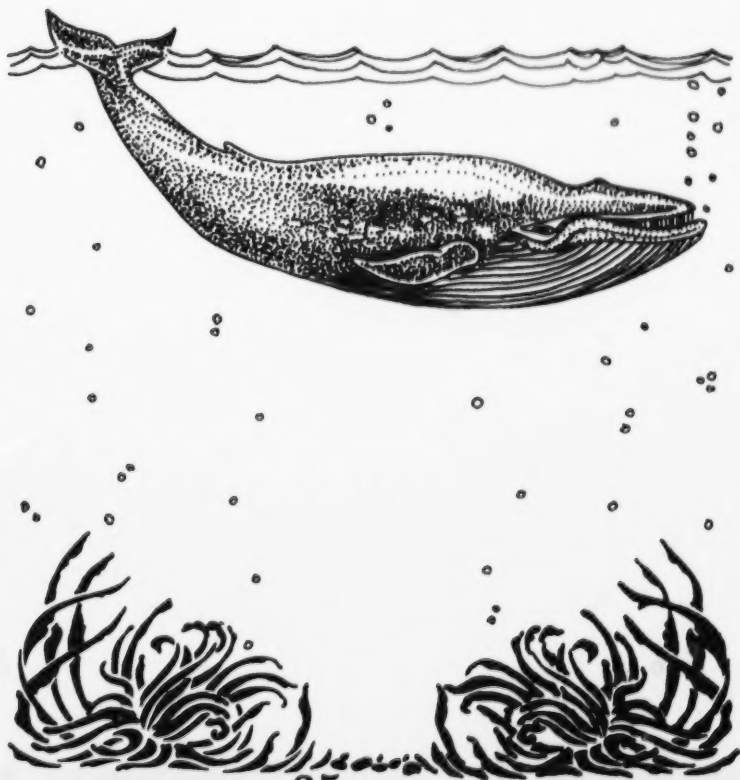
3. Organize a "Neighborhood Waste Watch" similar to Neighborhood Crime Watch, to oversee producers, transporters, treatment facilities, and storage sites.

4. Require all hazardous waste generators to prepare and implement a Zero Waste Discharge Plan, detailing step-by-step their time tables for achieving zero waste discharge.

5. Initiate a community recycling program that enlists local land-fill operators in serving as recycling centers.

6. Adopt building codes that encourage composters, greywater systems and other water conserving devices.

Clean water is not a Utopian fantasy. It is a biological, social, economic and spiritual necessity!



Clean Water Begins At Home

Home is where the cultural heart is; where society's patterns and values are passed from one generation to the next. Home is also the place where cultural transformation begins. Clean water begins at home in the same way that world peace and a life-sustaining environment begin there.



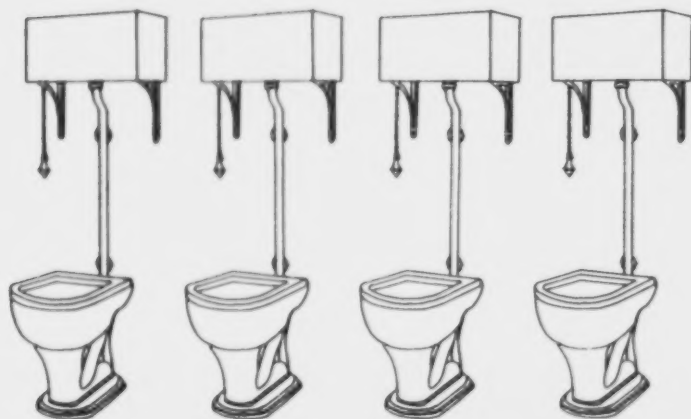
For most of history, people seldom deliberately mixed their excreta with water. Their "night soil", feces and urine, was returned to the soil. Chamber pots and outhouses were added niceties, but the end result was the same — the nutrients in the body products were returned to their origin, the soil. Springs, rivers and even wells were regarded as sacred. Water was only for drinking and cleansing.

This direct approach has always worked quite well in sparsely settled watersheds. The soil absorbs the urine immediately, and the countless organisms that live in and on the soil digest the feces into food for plants. Sunlight, heat, cold, and soil organisms make life difficult for any disease-causing bacteria or viruses that may have been excreted with the feces and urine.

As people moved farther from the soil into crowded cities, some other approach became necessary. In 1775, the first English patent for a water-flushed toilet was issued, but it was not an immediate success.¹ European housewives did not welcome the burden of carrying additional water to flush a toilet.

By the mid 1880's, water was being piped into the homes of many of North America's cities and the water toilet became a marketing bonanza. City dwellers tore down their overburdened outhouses and rushed to install these modern marvels that made their excreta vanish effortlessly.

Initially domestic wastes were flushed into cesspools and cesspits. These were replaced by underground sewer lines that carried the wastewater from homes and factories to the nearest waterway to be swept away — downstream.



Today many of North America's watersheds are overflowing with people and sewage. More by accident than by design, water resources are thick with residues from toilets and industries— residues that may have been "treated" but obviously not removed.

Our entire culture was toilet-trained to water in only a few generations. The fundamental measure of social competence and acceptability became the ability to relate successfully to a flush toilet. More than the car, telephone or television (and certainly more than the eagle), the water toilet is the symbol of our society.

In its change from novelty to apparent necessity, the water toilet also changed our culture's attitude toward water. The status of water plummeted from "sacred source of life" to "waste sump". At the same time, the water toilet changed our attitudes toward our body products. By interrupting the return of feces and urine to the soil, the water toilet hid their purpose as links in the food chain.

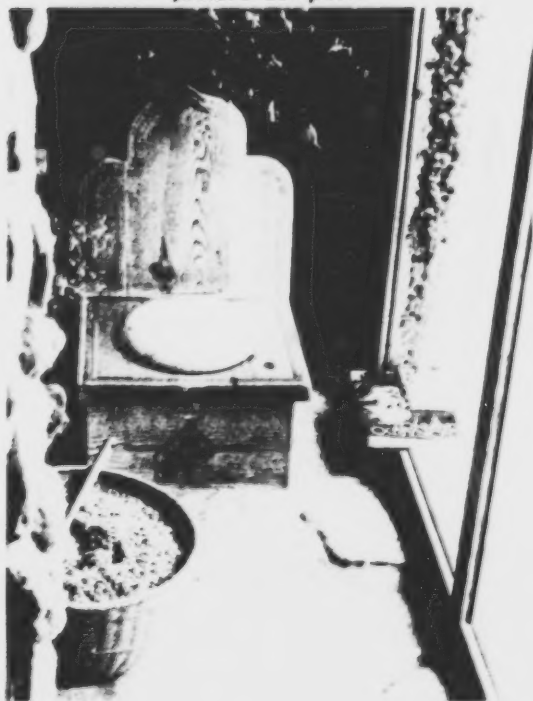
The water crisis was born out of the mistaken notions reflected by the water toilet — that water is only a waste vehicle and that our products are not participants in the food chain. To reclaim water resources from the flood of human and cultural excreta, our society must change its toilet habits.



Signs of the change are already obvious. Faced with losing irreplaceable water supplies to pollution, householders in every bioregion are changing their habits and taking personal responsibility for their own wastes. They are inventing new ways and turning to old ways that include:

1. Treatment of feces and urine that returns the nutrients safely to the soil.
2. Water conservation — using as little water as possible and returning it, fully restored, to its source.
3. Purchasing only those products that are biodegradable (compatible with the food chain) from industries who detoxify all of their by-products.

Judith's Composter



Adequate methods for treating body products do not transmit diseases. They do not offend the senses. They do not squander nutrients. No conventional water-based waste treatment system meets these criteria.

As described in Chapter 1, conventional wastewater treatment facilities are always sources of water pollutants. Few, if any, recover waste nutrients in a usable condition. And, despite many technological advances during recent years, wastewater treatment systems that do not have odor problems are few and far between.

Unfortunately, these systems are equally ineffective in preventing the transmission of some water-borne diseases. For example, the standard

procedure for disinfecting wastewater with chlorine, the most commonly used disinfectant, produces a treated wastewater that contains still-living bacteria, viruses and parasites. In fact, ordinary chlorination is known to be ineffective against the organisms that cause giardiasis, one of the most widespread modern water-borne diseases, some forms of hepatitis and other diseases. In addition, chlorinated wastewater contains significant quantities of trihalomethanes, cancer-causing chemicals that are produced by the chlorination process.^{2,3}

To be fair, there are a few innovative water-borne waste systems that may meet the criteria for adequate treatment of body products. One such system, custom-designed by its manufacturer, costs approximately \$20,000 per household, but it does evidently restore the water completely.⁴ Another less expensive option includes a low-flush toilet and holding tank. This system can be designed to operate as an anaerobic digester/biogas generator. However, its effluent requires further treatment to reclaim the water. And, of course, these systems do little to promote respect for water as a life-base resource.

There are dry waste treatment systems that do meet the criteria for adequate waste treatment, at low cost to the owner and at no cost to water resources. Some of these systems have been in use for over forty years; some are "new and improved". Commercially available and owner-built systems are described in detail later in this book.



The Ultimate Taboo

Thinking clearly about a subject often depends on having the words with which to think. If a thing is not named, it may not be given much thought. With body products, it is difficult to say which came first, lack of thought or lack of words. But in our society, there is a shortage of both.

In Shakespeare's time, there was no coyness or clinical detachment in talking about body products. But the simple, one syllable words that were used then became "dirty" words during the Victorian era. Today, we are left with quaint euphemisms and awkward medical terms: "go to the bathroom," "defecate," "answer nature's call," "urinate," etc.

Even the most "new age" publications on health and fitness still pretend that body products are insignificant, if not invisible. In nutrition and medical textbooks, excreta and excretion are usually given only prefatory mention.

This subject is such a taboo in our culture that we leave home, public school, college, even medical school, with almost no real knowledge about the products of our own bodies. Consequently, several generations of scientists and engineers have been designing systems for processing materials about which they know almost nothing.

For the householder or engineer who has an interest in building an effective, inexpensive system for treating and recycling feces and urine, here are a few fundamentals:

An average adult produces 1-1½ cups of feces per day. Vegetarians, who eat more fiber, generate more fecal matter. The feces of meat eaters are generally darker, denser and more odorous.

5,6

The bulk of feces consists largely of vegetable fiber and bacteria. Normal inhabitants of the colon (large intestine), the bacteria feed on substances secreted by that organ. In turn, they secrete other substances, such as some of the B vitamins, that are absorbed by their human hosts. In other words, these bacteria and humans have a *symbiotic relationship*, where each benefits the other.⁷

Normally, feces are at least fifty per cent water. They have a carbon/nitrogen ratio of 8:1, the same as humus-rich soil.^{8,9}

The average adult produces about four cups of urine each day. About 95 per cent water, urine carries most of the nitrogen and half of the phosphorous discarded by the body.^{10,11}

The concentration of disease-causing bacteria in the body products of a healthy person is seldom much greater than the number of such bacteria found in his or her saliva or even on some areas of the skin. Urine is normally sterile or almost so.¹²

The organisms found in feces and urine are easily destroyed by heat. One hour at 62°C (144°F); one day at 50°C (122°F), or one week at 46°C (115°F) have been found to be sufficient.¹³

When dried, the total daily production of feces and urine by an ordinary adult amounts to less than four ounces (1/2 cup) of solid material.¹⁴



Remember The Water

Conservation — simply saving water — is the cheapest and easiest form of water protection. *If we don't dirty the water, we won't have to clean it up!*

Since water toilets use 35-45 per cent of a home's water, a composting toilet is the most effective water-conserving device you can use. With feces and urine treated separately, the job of restoring the remaining wastewater, called "greywater" is greatly simplified.

Once a household has a composter that treats excreta and food scraps, the volume of wastewater can be reduced even further to as little as 15 gallons per person per day.¹⁵ This is done by using restricting faucets, showerheads, suds savers, etc. In a water-conscious household that conserves water, uses low or no-phosphate detergents (biodegradable, of course), and composts food scraps, this greywater can easily be restored. Some commercial and owner-built options for treating greywater are included in Chapter 6 of this book.

"Remember the Water"



What To Do With Body Products

Each of us is a manufacturer generating a daily quota of products — feces and urine. The way we use or misuse these materials has a direct impact on water quality, public health and soil productivity. The attitudes and practices we apply to these body products are the basic blueprint that we follow with the other products and by-products of our entire culture. In other words, people who learn to "flush and forget" at home will tend to do the same with the refuse of their factories and farms.

Taking a common-sense approach to the treatment of feces and urine is the first, and perhaps most important, step toward keeping water resources clean.



The Ideal Treatment

Every manufacturer dreams of raw materials that effortlessly transform themselves into the desired final product. Feces and urine are just such ideal raw materials. Kept in a container near room temperature, body products self-process into a safe, valuable material.

Like most other materials of biological origin, feces and urine emit gases and generate gases as they biodegrade. Most people have a strong aversion to the odors of these gases. So much so that in treating body products, protection from odors is as important as avoiding physical contact. Most people also have an aversion to the sight of someone else's feces.

So the ideal system for processing feces and urine will allow them to self-process into a sanitary, useful product without exposing anyone to objectionable sights and odors. Of course, this ideal system will keep all excreta, fresh and treated, out of the water supplies.



On-Site or Off-Site?

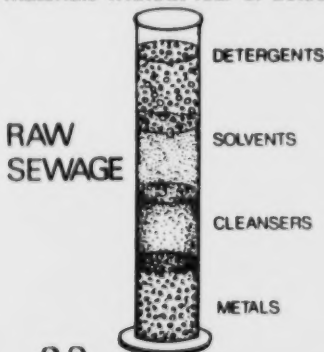
Is it safer, cheaper and more efficient to treat body products at their points of origin or to transport them to off-site locations for processing?

For years engineers have contended that the "economy of scale" (bigger is cheaper) gives cost advantages to systems with networks of collection pipes that carry solutions/slurries of excreta to a central facility for processing. If energy, building materials and clean water were cheap and abundant, they might be right. But in the real world of limited resources and rising costs, the most economical methods are on-site systems that do not require miles of underground pipelines and millions of gallons of water.

In most conventional central wastewater treatment systems, four times more money is spent on sewer lines than on the treatment plant itself.¹ Even so, the newest sewer systems are known to leak. In sizing treatment plants, design engineers and federal funding agencies routinely include a substantial allowance for rainwater and groundwater that enters the system through leaks in the sewer lines — infiltration.² It seems safe to assume that sewer pipes that let water leak in will also let sewage leak out.



Besides leaking raw sewage into water resources, sewage collection systems are themselves sources of toxic pollutants. Raw sewage, which is corrosive, has been found to leach heavy metals and toxic solvents from metal and plastic sewer pipes.³ Also, the easy accessibility of sewage collection networks invites abuse by those who can use them to get rid of toxic materials without fear of detection.



When a central wastewater treatment facility malfunctions, which they do quite frequently, the results can be catastrophic. Leaking wastewater lagoons have polluted groundwater supplies for square miles in some areas of the U.S. Overloaded treatment plants have been responsible for contaminating both surface and groundwater supplies all over the continent. ⁴

If an on-site waste treatment system develops problems, the people who are affected are generally only the few who use that system. Their proximity to the troublespot encourages an immediate solution.

In summary, off-site treatment by centralized, water-based systems is not cheap; it is not safe, and it does not keep human excreta out of water supplies. On-site treatment avoids the problems and expenses of transporting untreated feces and urine. Certain on-site systems produce a safe, dry fertilizer that can be used directly on the soil, keeping water resources free of excretal components. ⁵



Dry or Water-Based Treatment?

Water is the universal solvent. Once a substance is dissolved in water, the only physical means for separating solute and solvent is often by removing the solvent (water) by distilling it away. Imagine the expense of evaporating 30 gallons of water away from $\frac{1}{2}$ cup of excretal solids every day for every adult in the U.S.

One of the simplest ways of lowering the costs of water-based waste systems is to reduce the quantity of polluted water that must be restored. The growing number of one-cup, one-quart and one-gallon flush toilets that are on the market are welcome replacements for the old five-to-seven gallon flushers. Still, restoring water that is polluted with waste will always be expensive.

Besides distillation, another way to free water from excretal solutes is through biological uptake. Living organisms are encouraged to feed on the excretal nutrients and the resulting biomass is harvested out of the water. This method of restoring water can be through aquaculture, where aquatic plants are grown in the wastewater and harvested for other uses. Or it can be through agriculture or silviculture, where crops, grassland and trees are fertilized by sewage.

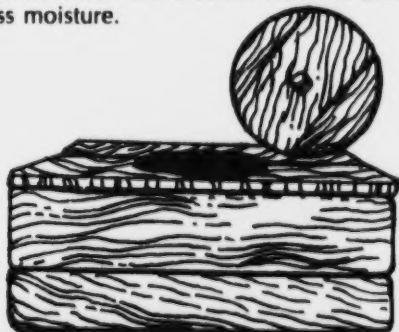
If the criteria for acceptable excreta treatment are to be met — clean water, affordable costs, safe product — consideration can be limited almost exclusively to dry systems. A few water-based systems can meet these requirements: closed loop systems that continually recycle and re-use water, and biological uptake systems which are generally large and multi-staged. These are very expensive to build.

The transition to dry excreta treatment will result in four major cost advantages:

1. Since dry treatment is cheaper to build and maintain, primary waste treatment costs will be lower.
2. Since dry treatment keeps excreta out of water resources, the costs of supplying clean water to homes and industries will be lower.
3. Keeping human excreta and its components out of the streams, rivers, lakes and oceans will increase their recreational value.
4. Returning excretal nutrients to the soil will increase soil productivity and decrease fertilizing costs.

Dry Treatment Systems for Body Products

Excreta treatment systems that approach the ideal process are already in use. In the U.S., Canada, Sweden and other countries, people have been buying commercial dry systems or building their own for years. Since water is the largest component of feces and urine, many of these systems are designed for additional input to achieve a dry final product. Some systems require absorbant materials such as sawdust, dry soil, peat moss, shredded paper. Some have auxiliary heating sources or air circulating units, while others use a combination of these techniques to evaporate excess moisture.



Composting Toilets

In a composting toilet, feces and urine undergo essentially the same aerobic biodegradation that takes place on the forest floor. Simple life forms, bacteria, fungi and insects, digest these body products. Only humus, a component of rich soil, is left. This process destroys the pathogens that may have been carried in the feces and urine.



Of course, in a composting toilet this process takes place entirely within the toilet — a vented, leak-proof container that encloses a bed of soil or compost. This aerobic composting process does not generate malodorous gases. The ventilation system of the toilet exhausts any odors associated with fresh feces and urine.

These toilets are of two major types. **Slow Composters** allow the accumulation of enough material to support the self-heating that is typical of large compost heaps. These also process food scraps and other biodegradable materials. **Fast Composters** are units comparable to the flush toilet in size and have heat sources to speed the composting process. In both types, the composting process reduces the volume of raw materials by about 90 per cent. One quart of raw materials will compost down to less than ½ cup of dry humus. ⁶

One variety of composter is the **Earth Closet Composter**. This type includes a commode that encloses a portable receptacle where excreta are covered with absorbant materials, traditionally dry soil, after each use. The portable container is emptied into a separate barrel or tank for composting. In another variation, plastic bags (preferably biodegradable plastic) act as self-contained composting units. This minimizes the problem of transporting feces and urine. ⁷

The **Vacuum/Composter** pulls the excreta from an in-house commode much like a flush toilet to a separate composting unit that also accepts kitchen and garden refuse.

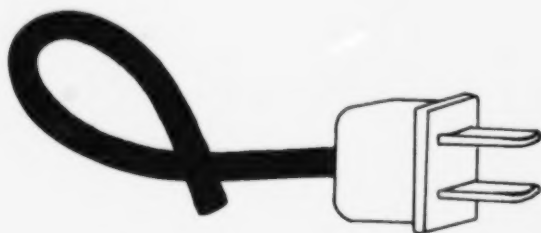
In the Swedish **Freeze Toilet**, excreta are collected and immediately frozen in individual plastic bags. The bags are subsequently taken to a composting barrel or tank. Electricity or gas is required to power this unit, which is not readily available in North America.

The **Pit Composter** has a leak-proof, excavated pit for the composting area located directly below a commode that is covered by its own shelter. Once the compost pit is full, it is covered until processing is completed. Then the commode/shelter is moved to a second pit. A double-vault composter allows alternating compost areas with one permanent structure.

Drying Toilets

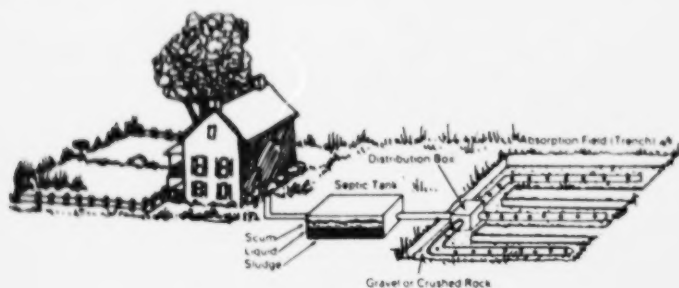
Incinerating Toilets apply intense heat, burning the excreta to ashes. These units are fueled by electricity, oil or gas and vented to the outside. The remaining ashes can be disposed of safely in almost any way.

In a **Desiccating Toilet**, heat (solar, electric, oil or gas) removes all of the water from the feces and urine. The timespan and temperature are adequate to destroy any pathogens. At this time, no commercial units are known to be available.



Water-Based Treatment Systems for Body Products

Septic tank/Leach fields are the most common on-site, water-based waste treatment systems in North America. The septic tank is a settling basin where solids are collected and digested into water-soluble components and a small quantity of intractable solids. The leach field is a network of perforated pipes that distribute wastewater through the soil.



The anaerobic digestion that takes place in the septic tank primarily converts solids to liquids so they can be carried out through the leach lines. The septic tank provides no actual excreta removal or water restoration. If either of these processes is to be accomplished, it must happen in the soil beneath the leach lines.

Most states require leach lines to be buried at depths of two to four feet below the surface.⁸ Since biological activity is most prolific in the top three to six inches of soil, there is little biological uptake of excretal components at this depth.⁹

Over time a mat, a living biofilter of simple life forms, may grow immediately beneath the leach lines. This mat may act as a filter, catching and holding some of the water-borne pathogens until they die. If the mat is not uniform, or is destroyed by toxics in the wastewater or by lack of water or nutrients, there will be less pathogen removal.¹⁰

With more time, the mat may become an impermeable mass, limiting the useful life of the leach field. To compensate for this, many regulating agencies recommend either two leach fields, used alternately, or the construction of a new leach field every seven years.

In any circumstances, the best that can be achieved by a standard septic tank/leach field is the attrition of pathogens and the simplification of excretal components. In rocky or impermeable soils, these systems are a common source of water-borne pathogens.¹¹

Every standard septic tank/leach field leaves a plume of nitrate contaminated groundwater. Most will eventually contaminate groundwater with phosphates as well. Some soils have a limited capacity for absorbing this nutrient.¹²

Conventional septic tank/leach fields do not meet the criteria for adequate treatment of body products. They do not keep excreta out of water supplies. The solids, or sludge, that collect in septic tanks must be taken to a central treatment plant for further processing, so no useful solid product is generated. And when operated according to official guidelines, emptying the septic tank every three years and replacing the leach field every seven years, septic tank/leach fields are not cheap either.¹³

In certain areas, some success has been reported with installing leach lines within the top few inches of the soil in the biofilter zone. This approach is limited to conditions of mild winters, year round vegetal growth, ample space, and low nutrient loadings in the wastewater (such as those of greywater alone).

The greatest improvements have been achieved by replacing the leach field with a controlled biological uptake system such as an **Evapotranspiration Bed or Harvested Aquaculture Pond**. For full wastewater, blackwater and greywater combined, these variations are both expensive and delicate.



Aerated Septic Tanks are growing more common. Some are advertised to "remove BOD (biochemical oxygen demand) and TSS (total suspended solids)". But BOD and TSS are simply measures of the condition of the wastewater — whether its components are in a complex or simple state and whether or not they are visible. Removing BOD and TSS can be accomplished without any reduction in the quantities of wastes in the water.

The advantage of aerated septic tanks is their increased destruction of pathogens and thorough digestion of the wastes. However, they remove no more excretal nutrients than any standard septic tank. Some units have incorporated a methanol feed system that does allow some nitrogen removal, but maintenance and operation has been problematic.

Other On-Site Alternatives

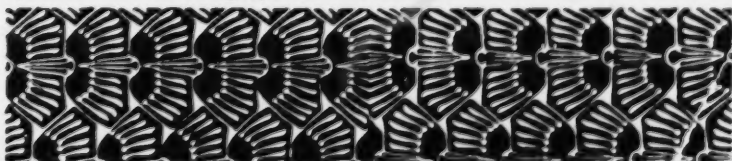
The most promising water-based excreta treatment includes the **Low-Flush Toilet or Pour-Flush Toilet with a Holding Tank**. The holding tank can function as both settling basin and anaerobic digester. However, tank effluent must be purified through agriculture, silviculture or aquaculture. If it is allowed to run into seepage pits, as is commonly practiced in Africa, India and the Middle East, it will produce a plume of nitrate-polluted groundwater.¹⁴



Recirculating Wastewater Treatment Systems can work well. They can also be highly technical, delicate and expensive. These include: a continuous aeration unit that aerates and re-uses the water that flushes the toilet; the algae digester, an experimental system that cleanses the recirculating toilet water by a combination of algae harvesting and biogas generation; and the total recycling system that cleanses the water through an elaborate system of tanks and filters.

An amazing amount of energy has been devoted to perfecting the water toilet and the treatment system it requires. There are **Chemical Toilets**, both one-way and recirculating, that use an aqueous solution of chemicals to mask the more undesirable properties of excreta without providing a final solution to their disposal. There are **Oil-Flush Toilets**, based on the immiscibility of excreta and oil as a means of separating excreta from its transport medium. Again, this requires a complex array of equipment without providing a final solution.

No doubt many people will continue trying to perfect the mistake of the water-flush toilet. Old habits die hard. But we know of no water-based system that meets all the criteria for adequate waste treatment. So we prefer to introduce you to effective, inexpensive dry treatment systems and encourage you to use them.



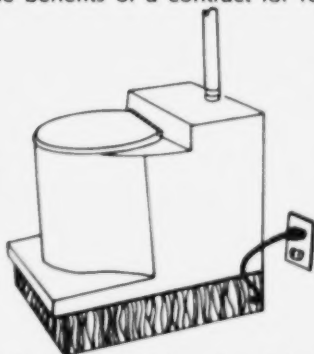
Commercial Dry Treatment Systems

The following dry treatment systems for feces and urine are available in most of the U.S., Canada and Mexico. The information, taken from product literature, is current for August, 1985. Suppliers can be contacted for more up-to-date advice..

These systems, like the rest of your tools (car, lawnmower, chainsaw, garden tiller, etc.) should be treated with respect. Read and follow instruction manuals and seek the advice of other owner/operators.

Just as with any other on-site system, these dry systems will require either your timely attention or the benefits of a contract for regular servicing.

HUMUS 80/M (formerly Multoa)



Concept: A small, self-contained system. Requires electricity to run the vent fan and electric element which supplies heat to speed decomposition. Human waste is broken down biologically by the action of aerobic bacteria in a safe, contained environment.

Requirements: Standard, grounded electric connection and vent components (supplied). No plumbing, water or chemicals.

Space: Slightly more than conventional toilet. No holding tank beneath floor.

Operation: Inside the Humus 80/M, waste is decomposed and sanitized by a patented system of biodegradation. Recirculated warm air evaporates urine and provides a good environment for rapid composting of solid human and paper waste into safe, dry humus. The humus devolves to removable collecting trays in an odor- and liquid-tight compartment in the base of the unit. Daily agitation by an externally operated mechanism assures proper aeration. A compost cover, which automatically retracts only when the toilet seat is weighted, conceals the composting chamber even when seat is raised.

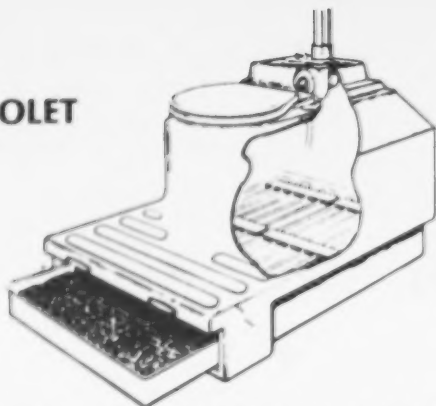
Product history: Manufactured by Sanitation AG of Sweden. Developed and tested in cooperation with the Microbiological Institute of the Agricultural University of Norway.

Model: Humus 80/M, white, self-extinguishing polystyrene; process components are stainless steel.

Cost: \$800

Available: Water Conservation Systems, Damonmill Square, Concord, MA 01742. 1-800-343-1706.

BIOLET and SOLAR BIOLET



Concept: Odorless, hygienic and non-polluting composting toilet. Coils containing hot water maintain tropical temperature and humidity within the Bioilet.

Requirements: 110 V electrical outlet and 2" vent pipe. Solar unit is heated by 250 watt electrical coils.

Space: Bathroom floor space of 28" x 40". Allow 20" in front to remove collection trays.

Installation: Simple installation. Plug in unit and put up ventilation kit. Can be done by owner.

Operation: Heat for rapid decomposition comes from hot water circulating through stainless steel tubing inside the Bioilet. Temperature inside waste is kept at about 96.5F. When more heat is needed, a small pump is turned on to circulate more hot water. Air is vented through roof. There are cutter bars, operated by handles, which remove the decomposed humus from the bottom of the pile and drop it into collection trays. Two trays collect clean, dry humus that require emptying no more than once or twice a year with normal use.

Capacity: 4 adults, year round use; 5-8 people less than full time; up to 15 persons for one 8-hr shift (industrial or commercial).

Product history: Made in USA.

Cost: \$1125

Available: Dale's Auto Electric, Bioilet Corporation, P.O. Box 645, Beatrice, NE 68310. 402/228-3384.

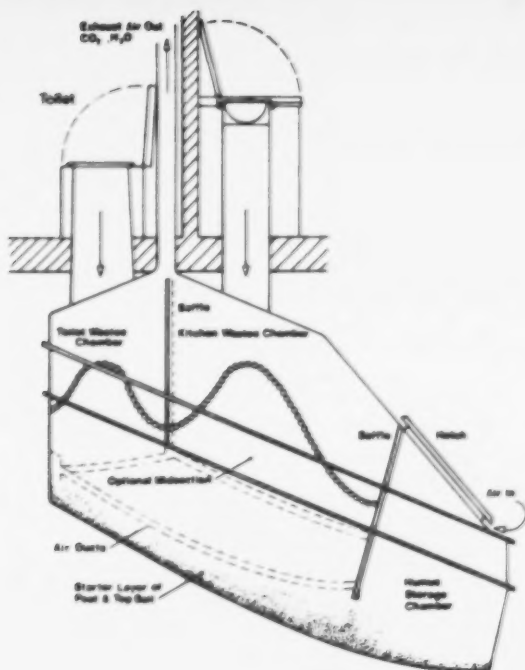
CLIVUS MULTRUM

Concept: Self-contained, waterless, odorless treatment system for all household organic wastes.

Uses no chemicals, heat or water; no polluting discharge.

Requirements: No plumbing hook-up. Electricity for small electric fan.

Space: Commode space in bathroom; kitchen waste inlet in kitchen counter. Room below floor for compost tank. Size of tank varies with number of people using system on year-round basis. Minimum area is 6' vertical with 4'x9' of floor space. Tank must be well supported and placed on a drained surface. Vent pipe extends vertically through roof.



Installation: Can be put in single floor or multi-story structures. Kitchen & toilet chutes should be vertical and the tank properly inclined and supported.

Operation: Components of system are: 1-2 commodes, kitchen waste inlet, chutes, composting chamber, vent pipe and small fan. Composting chamber has an inclined bottom, internal baffles and air channels to control air flow around and through the organic material. As the material decomposes, it moves in a slow, glacier-like manner along the sloping bottom. A small exhaust fan creates a constant draft which insures decomposition and odorless operation. This can be powered by solar cells. Frequency of removal will depend upon the household use. In a normal household, it will take 4-5 years before compost reaches the storage area. Once it reaches full operation the Clivus will deliver about 1.5 cubic feet of compost per person per year.

Product history: Used for over 35 years in Scandinavia. More than 5000 units used throughout the world. Pioneer of alternative waste treatment systems in U.S.

Approval: National Sanitation Foundation.

Cost:

Complete package, up to 5 people year round \$4270

Complete package, up to 9 people year round \$4670

Complete package, up to 15 people year round \$5070

(1985 prices; add shipping freight collect)

Available: Clivus Multrum USA, Inc., 21 Canal St., Lawrence, MA 01840. 617/794-1700.

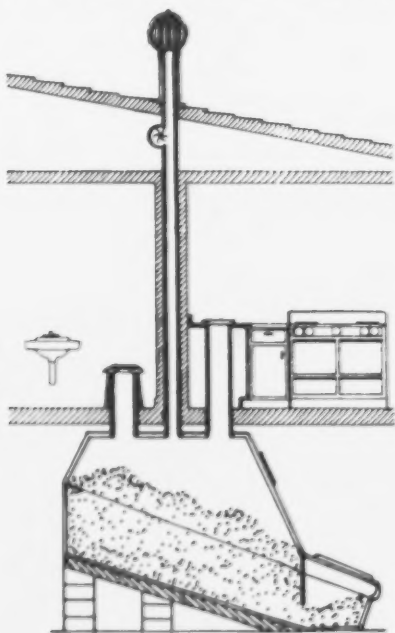
COMPOSTING TOILET SYSTEMS

Concept: Designed for odorless operation using natural aerobic decomposition. Baffle wall and airflow system are built into the compost tank. Natural air flow is assisted by an electric fan and a turbine fan (which runs free when the wind blows), combining to create a vacuum inside the tank. When you open the commode or garbage chute, air and gases are drawn out of the house.

Requirements: Space for commode in bathroom; space underneath floor for compost tank: 4'x9'x6'h. Can put two commodes on the system. Electricity needed for fan (uses about as much as 75 watt light bulb) or use solar panel chargers and batteries. Additional vent pipe may be needed for two-storeys.

Installation: Not difficult, but will take about 30 hours for the average handyman to install. Takes two people to position the tank. Easiest time for installation is during construction. Comes in complete form.

Operation: Compost must be removed at most once a year and liquid twice a year. Liquid is removed by opening the on/off valve on the drain. Liquid can be used as a soil builder on lawn or flower beds. Dry compost starter is used initially, then occasional additions of saw dust or peat moss. Bowl is cleaned with bowl brush, water and biodegradable soap. Has emergency access/maintenance door. Start-up time is 1.5 to 2 years. Garbage waste can also be added.



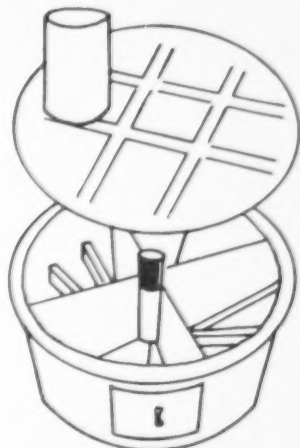
Models: CTS-410 Residential Kit. Includes all parts for four-person usage. CTS-710. Seven-person design for larger homes. Same included plus larger midsection. CTS-1010. For a ten-person home.

Approval: State of Washington; meets NSF Standard -41 criteria. Test results available on request.

Cost: CTS-410 Kit \$2895; Midsection for CTS 710 & 1010 \$370. Plus shipping (500 lbs).

Available: Composting Toilet Systems, Rt. 2 Box 770, Newport, WA 99156. 509-447-3708.

Carousel Composting Toilet



Concept: A composting system recommended for families larger than 2 adults and 2 small children using the system on a full-time basis. Design features 4 revolving chambers.

Requirements: Electricity is not required, but will assist the venting process.

Space: Room for commode in bathroom and space for large tank under the floor.

Installation: Needs one hole in the floor for the connecting pipe and one hole for the vent pipe on the roof. Container is placed under the bathroom floor. Must have access to the removal door of the revolving chamber.

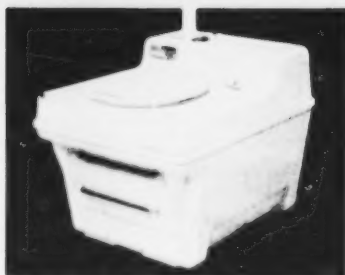
Operation: Peat moss and soil must be added at the bottom of each chamber before initial use. When one chamber is filled, the inner container easily turns to place another chamber into position, usually only twice a year. All chambers are full after two years. Removal door to the outer container and to the inner container should then be opened and the odor-free compost can be removed from the first chamber, preparing it for reuse.

Models: *Small Model.* About 30" high. Recommended for families larger than 2 adults and 2 small children. Each chamber has volume of 5 cubic feet. *Large Model.* About 50" high. Normally used on a continuous, year-round basis. Equipped with heating system and ventilator to speed composting process. Larger capacity container.

Cost: \$1733 Small Model; \$2133 Large Model. Plus shipping.

Available: Water Conservation Systems, Damonmill Square, Concord, MA 01742. 1-800-343-1706.

ENVIROLET by Sancor



Concept: An aerobic and evaporation toilet system also using natural organic breakdown process.

Requirements: Electricity—120 volts, 60 cycles, 540 watts max. Vent kit (package separately).

Space: Bathroom floor space: 25" w x 33" l x 25" h.

Installation: Can be installed in less than one hour. Requires the simple connection of a vent kit included with purchase.

Operation: Evaporates water out of the wastes by means of an engineered aeration system. Air vent carries water vapor outside. Remaining waste material is transformed into clean, dry soil. Done by continuous action of the forced warm air and natural organic breakdown. Activator and peat humus supplied for start-up. Operates continuously. Only a small amount of soil residue must be removed about once per year, depending upon usage. Soil is raked by a built-in Rake Bar into an enclosed Soil Collecting Tray and removed.

Capacity: Cottage: 3 adults and 3 children (vacation); Home: 2 adults, 3 children; Industry: contact Envirolet for specifications. Can accommodate increased usage of 1-2 people for 1-2 days.

Product history: Thousands sold throughout the world.

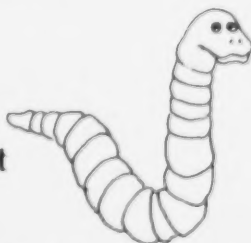
Model: Envirolet Multi-system/10. Designed to provide increased capacity and to eliminate the need for different size models.

Approval: Canadian Sanitation Association.

Cost: \$868 delivery pre-paid. Accept VISA, Mastercard

Available: Composting Toilet Systems, Rt. 2, Box 770, Newport, WA 99156. 509-447-3708. AND Bio-Sun Systems, Box 196, R.D. -2, Miller-ton, PA 16936. 717/549-6355 or 549-8250.

BIO RECYCLER: The Amazing Worm Toilet



Concept: A waterless vacuum system which uses red worms to facilitate the composting process.

Requirements: Electricity needed for vacuum motor. Used only when toilet is in use.

Space: Space for toilet in bathroom. Space nearby for container in unheated insulated workshop, cellar, garage or shed. Size of container is 3' diameter by 6'6" height. Vacuum tubing runs from toilet to container.

Installation: Shipped in kit form. Simple installation.

Operation: To use, press foot switch down; valve opens; vacuum comes on. Use toilet. Spray hopper with 1 or 2 oz. of water with garden sprayer. Raise foot switch to shut off. No odors or bugs. No loss of heat through vent system. Remote container has its own vent system. Monthly, or as needed, a small amount of finished compost is removed from the rear hatch by pulling it with a hoe into a bucket beneath the hatch. A 5 gallon drainage bucket is periodically switched with an empty bucket when full.

Leaves, sawdust and kitchen scraps may be added through a centrally located loading hatch at the top of the container.

Capacity: Not recommended for vacation or part-time use.

Product history: On sale at least since 1978; marketed by Jeremy F. Criss.

Model: Bio Recycler Home Waste Recycling System.

Cost: \$1800 plus freight

Available: Bio-Recycler, 5308 Emerald Drive, Sykesville, MD 21784. 301/795-2607.

INCINOLET JEWEL



Concept: Uses electric heat to incinerate all human waste to clean ash.

Requirements: Electricity, but no plumbing, or water.

Space: Uses only the fixture space above the floorline.

Service: No outside service. Manual removal of bacteria-free ash from stainless-steel ashpan; 2 minutes once or twice a week. Ash may be dumped in garbage sack or used on flower garden. Wax paper liner used with each usage. Surfaces cleaned by wiping with a damp cloth.

Models: *Model TR System.* Industrial toilet system for 1 to 6 people. Use where personnel will be familiar with operation & proper usage of system. *Model UR Urinal System.* Drains urine directly from bowl to incinerator chamber. No liner needed. Serves ten men. Use by pressing button. Suitable for short-term users.

Installation: Bolt Incinolet to floor. Put up 4" ventline; seal joints; terminate with vent cap. Connect power—120/208 or 240 volts AC, single phase.

Odor Control: Uses proprietary catalyst system. Small pellets of heat-activated catalyst located within the incinerator walls cause a chemical change in the odor molecules before they enter the ventline.

Product History: Continuously manufactured since 1958 by Research Products/Blankenship Corp. Used on diesel locomotives, electric utility stations, industrial plants, underground mines, tugboats, cranes, security gates, lake cottages.

Approval: Underwriters Laboratories; US Coast Guard; National Sanitation Foundation; Canadian Standards Association.

Cost:

Model TR-VI Deluxe Industrial Toilet—\$1995

Model UR-VI Industrial Urinal\$1995

All Electric Restroom\$3695

Installation Kit60

Turbine Cap25

Bowl Liners/20015

Available: Research Products/Blankenship, 2639 Andjion, Dallas, TX 75220. 214/358-4238.



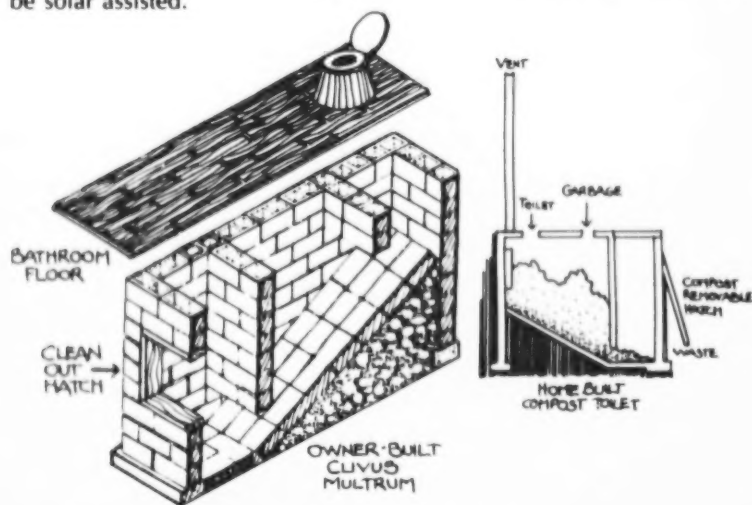
Owner-Built Dry Treatment Systems

Plans for owner-built decomposition systems have been published in various forms for the last 10-12 years. This chapter reviews the types of systems that can be feasibly owner-built and provides sources for further information and/or detailed plans for construction.

Owners and users have found these designs to be useful and acceptable, but every builder/user has new insights and makes improvements.

"MULTRUM" TYPE COMPOST LATRINE

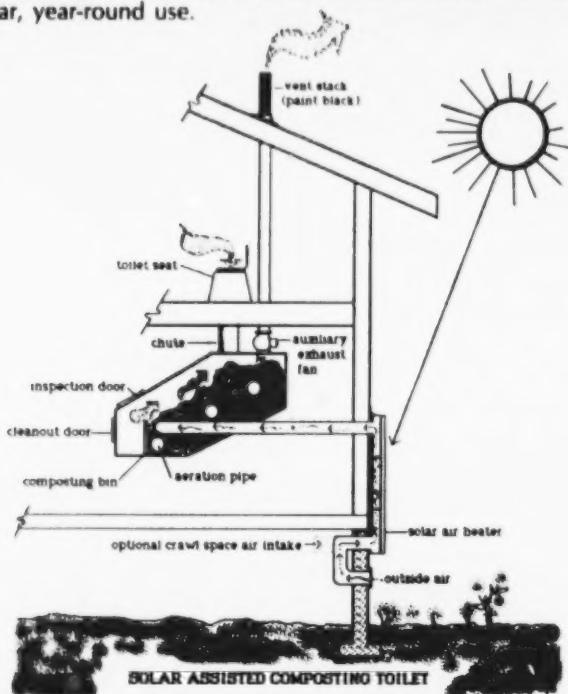
Developed in Sweden about 45 years ago, this system consists of a receptacle with a slanting floor, air conduits, and a storage chamber at the lower end of the receptacle. A tube connects the commode in the bathroom with the receptacle and there is often a special chute in the kitchen for scraps. The manufactured "Clivus Multrum" system is based on this design. The receptacle can be made of concrete or assembled from prefabricated fiberglass parts. The decomposition process may be solar assisted.



The floor of the receptacle is inclined about 30 degrees and covered with a starter bed of peat moss and humus-rich garden soil mixed with grass cuttings. This is to absorb liquid and provide microbes for oxidizing the urine. As the system is used, a compost heap builds up in the receptacle. The slope of the floor causes new deposits to slowly push the older compost toward the bottom of the receptacle to the storage chamber. As it moves downward, the decomposition process reduces the heap to less than 10 per cent of the original volume.

The end-product, a dark, dry humus, is removed from the storage chamber. This is a very slow process, and it may take five years before the first humus needs to be removed. After that once per year is usually sufficient.

The maximum number of users a multum can accommodate depends on temperature of the receptacle area, humidity, amount and type of kitchen refuse, the proportion of urine to feces and volume of the receptacle. Usually 8-10 people would be the maximum for one unit in regular, year-round use.

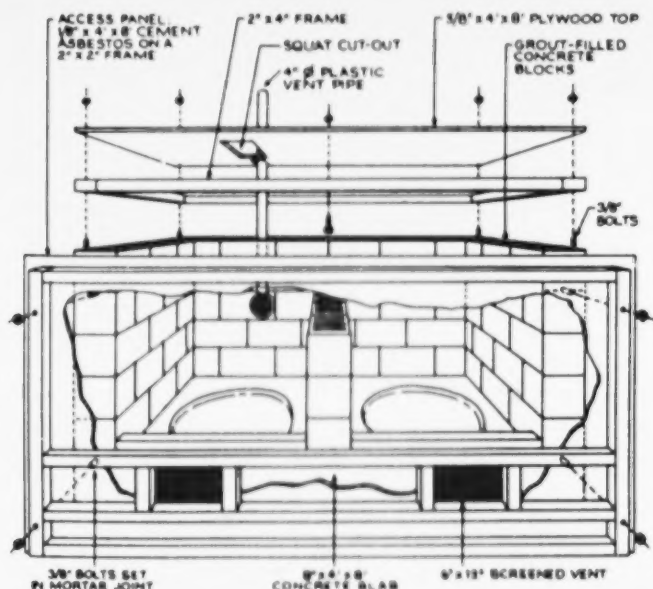


The plans presented here are for a "Solar Assisted Composting Toilet" produced by Ron Hughes of the Arkansas Energy Office, One Capitol Mall, Little Rock, AR 72201. 1-800-482-1122. You may obtain a list of suppliers for components and general information for this system from this address or from The Water Center. New Life Farm has also published a fact sheet on composting toilets which includes plans for this system. Write New Life Farm, P.O. Box 129, Drury, MO 65638 or The Water Center.

FARROLONES COMPOSTING PRIVY

This composter consists of a two-chamber concrete box 4'x4'x8'. It has a plywood top with an opening over one chamber. The front of the box has two removable plywood doors with screened air inlet vents. There is also a 12" square plywood vent stack which is screened on top. The compost pile in the first chamber is turned and mixed with a pitchfork or shovel used just for this purpose. After 6 months, the pile

is turned to the second chamber, used just for storage. It is left here for another 6 months of composting, then removed as clean, dry humus.

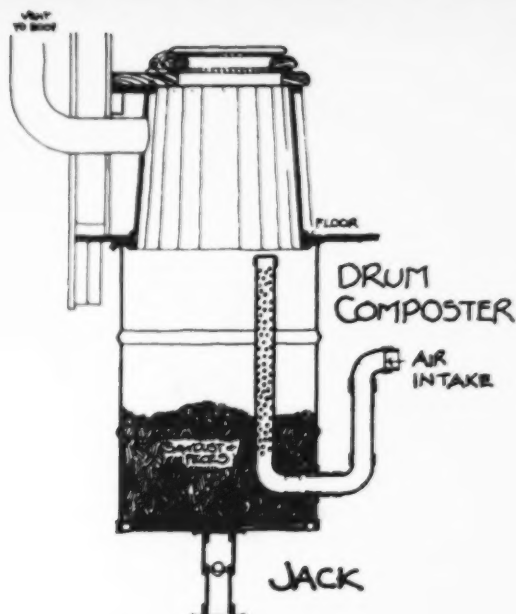


The construction of this system is detailed in "Technical Bulletin No. 1, Composting Privy" available from The Farallones Institute, 15290 Coleman Valley Road, Occidental, CA 95465. Cost is \$2.00. It also contains good general and specific information on composters and the decomposition process.

DRUM COMPOSTER

This is one of the simplest owner-built systems and one of the cheapest. It consists of an open-top 55 gallon drum with perforated plastic tubes inside to admit air. A wood seat with a sealed lid can be made to fit tight on top of the drum itself, or the drum can be jacked up under a hole in the floor and covered by a commode or squat plate with a tight lid. It will take two people about three months to fill the drum. It is then resealed, removed, and allowed to sit in a sunny spot until the decomposition process is completed. The drum can then be cleaned out (except for a little left for "starter") and reused.

Good drums usually cost \$10-20. Get those with removable tops, a clamp that holds the lid tight, and a lining of baked-on phenolic resin (incorrectly call "teflon lined") inside to prevent rusting. The best sources for this type of drum are farm feed mills (molasses), honey farms and food processing plants. The drum should have a flat black exterior and a two inch bung hole on the side, near the bottom for the vent pipe. Air intake pipes inside the drum are made from 2" perforated plastic pipe. Another pipe goes an inch or two inside the drum and serves as



an exhaust stack; it must extend higher than the seat. Air passages through the drum are the most important part of the system. They provide oxygen and take away moisture and carbon dioxide.

As with other decomposition systems, the drum composter requires a "starter culture", 10-15" of dry hay, peat moss, etc. After the first start-up, the drum is never completely emptied to provide starter for the next batch. Material other than human waste must be added such as peat moss, chopped leaves or cotton seed hulls. Sawdust may be used sparingly, but it should be from hardwoods. The compost requires mixing. The drum may be recapped and rolled once or twice, or a short wooden fork is hung inside the toilet and used for turning. A urine diverter will make this system function more effectively.

This drum design has been presented by the Farrollones Institute and others. "55 Gallon Drum Compost Toilet Guidebook & Plans" is available from Stan Slaughter, Rt 17, Vale Road, Kansas City, Mo 64138 (816) 765-6125 or from The Water Center.

COLLECTION-TRANSFER SYSTEM

This is a simple, low-cost decomposition system in which the commode itself is not directly connected to the large composting bin. A smaller receptacle is periodically emptied into the large compost bin. If designed and operated properly, it is essentially odorless, both in daily use and in transfer.

In one version of this system, a sealed, vented wooden commode that holds a 2-5 gallon receptacle is installed inside the house. With every use, the system is "flushed" with a cup or more of dry soil, sawdust, peat moss, etc. When convenient, the portable receptacle is emptied

into a large composting bin, drum or vault that is located outside the house.



COLLECTION-
TRANSFER
SYSTEM

In a more complex system, the commode and shelter are built above ground on stilts, with the area underneath lined with heavy gauge plastic and screened in for ventilation. A washtub-size container with handles is placed, on bricks, under the toilet seat. The commode closes with an airtight lid and is removable to allow access to the tub from above. The lower back part of the system is also removable or hinged for tub removal. A vent pipe from the tub area is added for further ventilation, especially if the system is installed indoors. For indoor use, the commode must be placed against an outside wall for access to the waste tub.

Small holes are punched in the bottom of the tub to prevent moisture accumulation. The key to successful operation of this system is to eliminate excess moisture in the waste tub. A urine diverter is used. Feces are covered with wood ashes or dry dirt. Toilet paper is placed in a waste-paper basket. (It dries in a day and can be used for fire tinder.)

The compost bin consists of four compartments arranged in a square. These are made of rough lumber or slabs. Each bin is about 4'x4'x4', with a removable wall for easy turning and removal of compost. The bins are lined with heavy waterproof plastic and covered by screens. Perforated plastic pipe can be inserted through openings in the sides of the bins to increase air flow through the compost.

When the first bin is filled with wastes transferred from the privy and kitchen scraps, the compost is shifted to the next bin. This process is followed for each bin until they are all full. Then the clean, dry humus is removed from the fourth bin and can be spread on the garden or orchard.

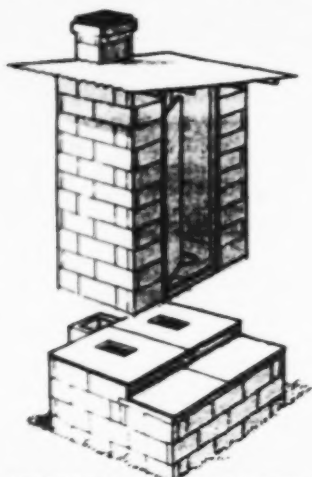
This collection-transfer system is labor-intensive in its use. But it does the job and can be constructed for around \$100. It would probably be most suitable for a rural setting.

Information for this system was taken from "A Simple Low-Cost Rural Compost-Privy", an article by D.P. Grimmer and M.A. Schliekelman published by *Appropriate Technology Research*, 1938 Hano Rd., Santa Fe, NM 87501.

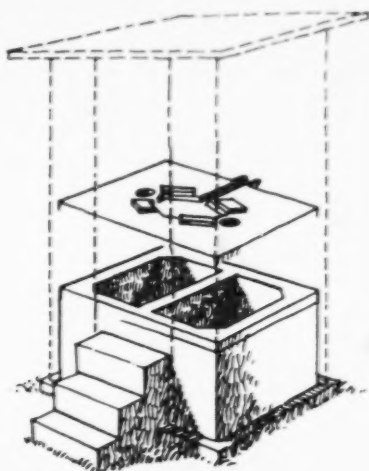
DOUBLE-VAULT COMPOSTER

This is a compact, versatile unit whose basic structure can be varied in a number of ways. It was developed in North Vietnam in the 1950's. The Farralones Composting Privy seems to be based on this plan also.

As with any system, if there is a tight receptacle, there will be no groundwater pollution. If there is a chance of seepage, the system must be placed downhill from the well or other water supply. If the area where you are building is flat and waterlogged, you should place it on a mound and provide a watertight floor.



DOUBLE-VAULT COMPOSTER



VIETNAMESE
DOUBLE-VAULT COMPOSTER

VIETNAMESE DOUBLE-VAULT COMPOSTER

The basic idea behind this double-vault system is two chambers and a urine diverter. One chamber is used until two-thirds full, then sealed, and the other chamber is used until two-thirds full. The first chamber is then emptied of what has become clean, dry humus. This is done through an easily accessible door in the rear of the chamber.

It is important that the commode seat or squat plate have a cover that seals well to minimize insects. Before first time use, the floor of the chamber is sprinkled with powdered earth to absorb moisture from the feces and provide some of the micro-organisms for the decomposition process. After each use, the dry absorbant (sawdust, peat moss, dry soil, ashes, etc.) are sprinkled over the feces to absorb moisture, curtail bad odors and insects. Urine is drained away and collected in a jar — either empty or filled with ashes.

OFFSET DOUBLE-VAULT COMPOSTER

A variation of the double-vault composter is one in which the collection receptacles are not located under the commode or squatting slab, but placed to the side and connected by a chute. In Mexico a solar-

heated double-vault composter has been developed. There is a seat riser above a baffle between the two chambers, which directs input to one of the chambers. When that chamber is full, a handle is turned and the input falls into the other chamber.

The chambers extend outside and are covered with black painted aluminum sheet lids which face south. These act as solar collectors and increase evaporation and raise the temperature of the compost pile. The capacity of the system can be increased by manually using a hoe to shift the pile to the rear of the chamber. This means that the system has to be emptied once a year at most with regular use by 6-8 people.

An excellent book on low-cost decomposition systems is "Sanitation without Water" by Uno Winblad and Wen Kilama, published by the World Health Organization. It gives details for the construction of these systems and many others, as well as general maintenance information.



LIQUID ASSETS (or THE BEST THINGS IN LIFE ARE FREE?)

By Evi Seidman

Mountains, boulders, stones and rocks
Don't buy and sell like bonds and stocks
Rivers, lakes, and deep cool springs
Are a few of my free and favorite things

Econo-me, econo-you, econo-us
We either all get rich or we all go bust
You can't cut the trees and muddy the lake
And expect to take and take and take
The land is rich but the soil is thin
The Earth can't lose, but YOU still WIN

Econo-me, econo-you, econo-us
We either all get rich or we all go bust

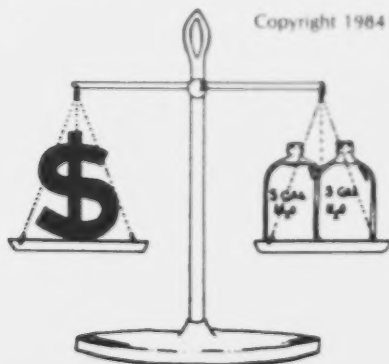
The flow of cash and a river's flow
Is much the same if you know how to row
What you dump in can't be dumped out,
Now you can't drink the water without this doubt

Econo-me, econo-you, econo-us
We either all get rich or we all go bust

If it starts to hurt as these facts soak in
Just think of the trees in the acid rain
Our water, our soil, our air's in hock
Time is money, just look at the clock

You think more is coming so you can waste
Run a credit check on the human race
We're spending the future with the faucets on
The Earth's our bank — and we're overdrawn

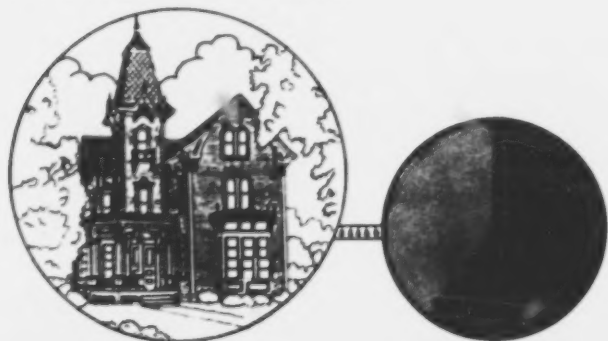
Copyright 1984 by Evi Seidman.



Chapter 6

Greywater Restoration Systems

Greywater is the water that a household uses for bathing, laundry, dishwashing, etc. In a typical "wastewater home", greywater accounts for 60 per cent of the total wastewater. The remaining 40 per cent is flushed down the toilet as *blackwater*.¹



Besides dirtying only 60 per cent as much water as a home with a water toilet, a "cleanwater home" with a composter for excreta and kitchen scraps also generates a much cleaner wastewater. The nitrogen content of the greywater from such a home is 84 per cent less than the nitrogen content of the wastewater from a home with a flush toilet.² If the cleanwater household uses low-phosphate detergents, the phosphorus content of their greywater is 82 per cent less than that of a typical wastewater home.³ Also, the number of bacteria, viruses and parasites found in greywater are much lower than those of typical wastewater.⁴

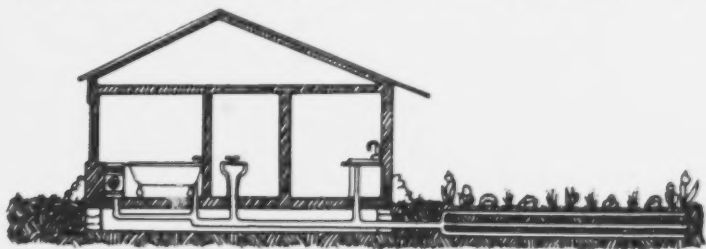
Despite its simpler, less concentrated nature, restoring greywater requires careful attention. That attention begins at the faucet. By using the water-saving devices and techniques described in Chapter 7, each person's contribution to household greywater can be kept under 15 gallons per person per day. Being thoughtful about what goes down the drain, for example using only biodegradable products, will generate greywater that is compatible with the simpler, cheaper greywater systems that rely on biological uptake by living organisms — *bioassimilation*.

Agricultural Systems

One of the most important steps in greywater restoration is the removal of dissolved nutrients. Bioassimilation followed by harvesting the new biological growth is cheaper and more efficient than any chemical/mechanical technique. In simpler terms, the easiest, cheapest way to get nutrients out of greywater is to let some living organisms feed on them and then harvest the new growth that results — agriculture, silviculture or aquaculture.

Agricultural systems may be as simple as a roughing filter and a hose to a flower bed. However, official sanction sometimes requires a more

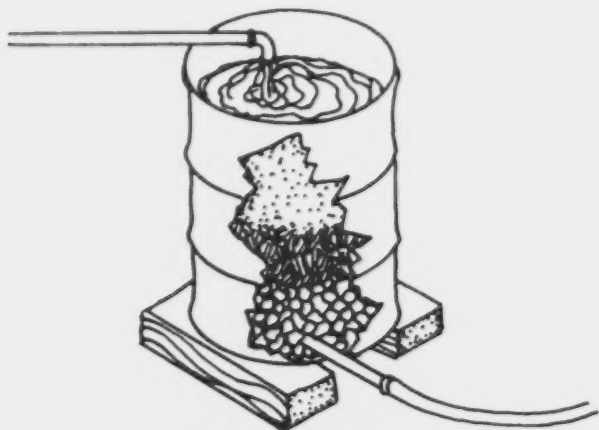
formal approach, such as a small septic tank with leach lines placed in the uppermost, biologically active soil zone. This allows nutrients to be absorbed from the water by plants and other organisms before it percolates down to join the groundwater. Leach lines may also be built in soil beds, either in greenhouses or outdoors with evergreen vegetation. In silviculture, the greywater is fed to trees in forests or woodlots by overland flow or by systems similar to drip irrigation.

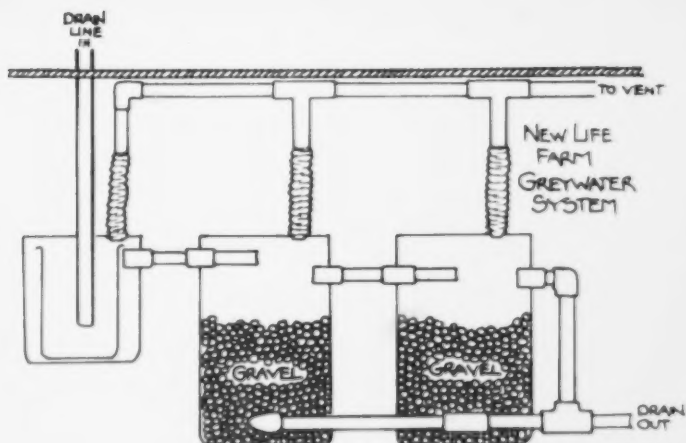


In some aquaculture greywater systems, algae feed on the nutrients. The algae is then harvested directly from the water or fed to fish and mollusks which are then harvested. Alternately, aquatic plants, such as duckweed and water hyacinth, are grown in the greywater and harvested. Aquacultural systems usually require leak-proof tanks or ponds, mild ambient temperatures or greenhouse environments, and timely harvesting.

Roughing Filters

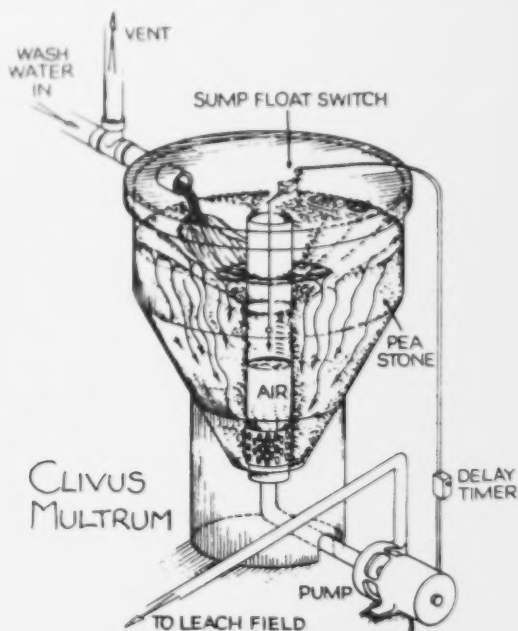
The first step in restoring greywater is to remove grease, particles and solid residues. This can be accomplished by an owner-built roughing filter. Such filters are based on a 55 gallon drum filled with layers of gravel, sand, wood chips, hay, or removable mesh screens, and fitted with vents. A simple roughing filter for small amounts, 30-50 gallons per day, is illustrated. A more elaborate system developed by New Life Farm is also shown.





Clivus Multrum, mentioned in Chapter 4, makes a roughing filter for about \$450. It filters the greywater and aerates it, speeding up the decomposition of organic matter.

When a filter is used, it must be kept warm for proper operation. Greywater is usually about 15 degrees F warmer than combined greywater and blackwater. Insulating the filter will help conserve this heat. If grease is habitually poured down the kitchen drain, a grease trap will prevent clogging in the roughing filter.

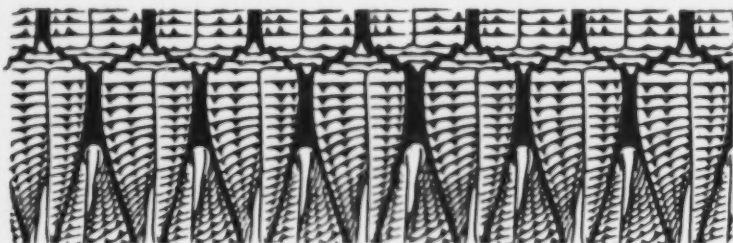


Septic Tank

A standard septic tank can also be used for primary greywater treatment. Since there is less solid matter in greywater, the frequency with which the tank must be pumped will be considerably less than that required for a septic tank receiving combined greywater and blackwater.

An anaerobic filter installed at the septic tank's outlet will reduce solids carryover, extending the life of the leach field. **Enviroscope, Inc.** markets a greywater tank that features aeration and an extended retention time to lessen solids carryover.

Once greywater has passed through a roughing filter or settling tank, it is ready for biological restoration by the agricultural, silvicultural or aquacultural approaches described earlier.



Trickle Systems

Some greywater restoration systems are modeled after municipal wastewater facilities that use overland flow and irrigation. After being filtered or settled, the greywater is applied to gardens or lawns via trickle irrigation pipes, hoses or buckets.

In the trickle system, perforated pipes, running slightly downhill, are laid near the soil surface. It is important to spread the water over a large area, so a single outlet such as a garden hose, must be moved periodically. To prevent runoff, the garden or lawn must be fairly level, terraced or mulched. If there is a long dry period, irrigation with greywater should be augmented with freshwater to prevent any buildup of salts in the soil.

Greywater Application

Some authorities recommend that greywater be applied primarily to ornamental plants. If used on edibles, these precautions are recommended.

1. Avoid splashing above-ground parts of plants.
2. Wash vegetables thoroughly before eating.
3. Use only on plants whose edible parts are well above ground.
4. Use on well established plants, not seedlings.
5. Monitor the pH of the soil, since greywater is often alkaline.
6. If greywater contains fecal matter, as from washing diapers or from urine, disinfection may be required. Ultraviolet, ozone, chlorine, and iodine disinfection units are commercially available for \$100 to \$400.

Chapter 7

Saving Water and Money

"A penny saved is a penny earned." But the water you save is priceless. Every gallon of water you *don't* use is one gallon less to be stored and distributed —lower costs for water supplies such as dams, reservoirs, or wells. It is one gallon less to be purified before use —lower water treatment costs. It is one gallon of water that won't have to be restored —lower wastewater treatment costs. And it is one gallon less to be heated for washing and bathing —lower energy costs. Saving water saves money, and it saves clean water sources from pollution.

Consider the milk cooler in your grocery store. It may hold as many as 300 one-gallon jugs of milk. Fill all 300 jugs with water; stack them in your living room. You now have a vivid example of the amount of clean, drinkable water that the average U.S. family of four uses every day.

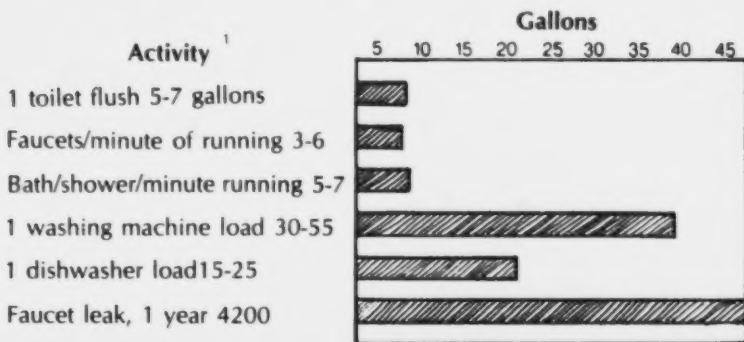
About 95 per cent of this water, 285 gallons, ends up as sewage. 120 gallons is flushed down the toilet and the remaining 165 gallons go down household drains carrying shampoo, detergent, cleanser, food scraps and dirt.

Obviously a dry toilet saves more water than any other water-conserving device, since it reduces water use by about 40 per cent. With faucet aerators, flow-restricting showerheads, and other shelf items from the local hardware store, that typical family's stack of 285 jugs of water-to-become-sewage can be reduced to only 60 gallons of greywater.

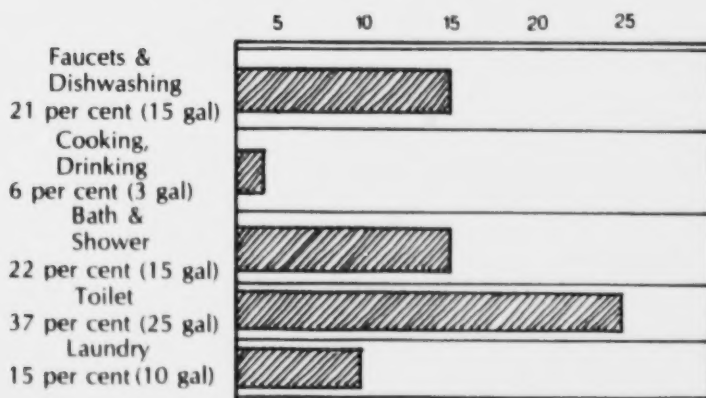
Water-saving devices are generally inexpensive and available at hardware stores and plumbing supply houses. Most can be installed by the owner in less than 30 minutes.

A standard bathroom and kitchen can be retrofitted for water conservation for as little as \$24. Savings in water heating expenses alone will return the full investment within three months with a conventional water heater. For a tankless, on-demand heater, the payback is less than one month.

Depending on the type of plumbing fixtures and habits, household water use ranges as follows:

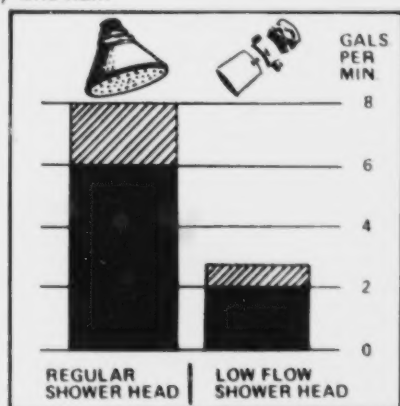


Typical Household Water Use/Wastewater Generation Per person per day. Indoor use only. ²



Common Water Conservation Devices

For Shower: Low Flow Shower Head. Device that replaces conventional shower head but still allows the feeling of a full shower. Conventional: 5-7 gallons per minute; Low-flow: 3 gallons per minute. Water use reduced by one-half.



For Faucet: Aerator. This is a flow constrictor which reduces water flow and increases pressure, and a fine mesh screen to mix air with faucet water. Conventional: 5-7 gallons per minute (some can use up to 15 gallons per minute); Aerator: 3 gallons per minute.

For Toilet: Toilet Dams. These devices reduce the flow from a tank-type toilet without reducing cleaning and flushing action. Dams are usually rectangular pieces of plastic or rubber-coated metal which can be arched and inserted vertically into the tank between the back and front walls. They create two pockets of water on each end of the tank

which are held back when the toilet is flushed. Conventional: 5-7 gallons per flush. Since 1978, most new toilets use $3\frac{1}{2}$ gallons per flush. Dams: can save up to 1 $\frac{1}{2}$ gallons per flush in older toilets. Dams are not suitable for pump tank or "low-boy" toilets. Newer $3\frac{1}{2}$ gallon models may not clean properly with dams, but it's probably worth a try to make a $3\frac{1}{2}$ gallon tank use only 2 gallons per flush.

Shopping List

For each toilet:

One set of two rubber dams which fit into the upper tank of the toilet.
Cost: approximately \$10 per set.

For each faucet:

One low flow aerator (3 gal/min. or less), compatible with the thread pattern on your existing faucet. Cost: \$1-2 each. (Note: older faucet frequently have unthreaded spouts. Aerators with friction or "push-in" fit are available, but can be hard to find. See "Sources of Supply" if not available locally.)

For each shower:

One showerhead rated at 3 gal/min or less. The best ones have a shut-off valve on the head itself which allows you to turn off the water without adjusting the temperature. Cost: \$6-\$12 each. (Note: if your showerhead is attached to the wall pipe by a ball joint instead of screw threads, you will also need a standard "shower nipple", commonly available for under \$5. It will have standard external threads on both ends. Carefully remove the old nipple with a pipe wrench by unscrewing it from the pipe inside the wall. This can get tricky, so you may want to have a plumber do it.

Also have available:

Food coloring (to test for toilet leaks)

Teflon joint tape

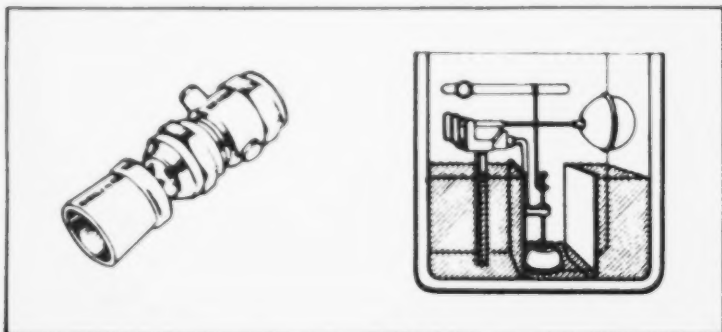
10" pipe wrench

10" adjustable wrench

Rags for padding & wiping

Penetrating oil for sticky joints

These purchased water conservation devices come with manufacturers' instructions for installation.



Low Flush Toilets

To achieve an even great saving of water, a low-flush toilet can be installed. Since the toilet uses almost 40 per cent of the average household water and produces the blackwater which is the most difficult to repurify, this is a rewarding target for water conservation.

Most of the low-flush toilets require no special plumbing alterations and work like a regular flush toilet. They use less water because of design changes in the bowl shape, trap pitch and water column height. They are easy to install and results are immediate. A few models are detailed here. Information is taken from the manufacturer's product literature.

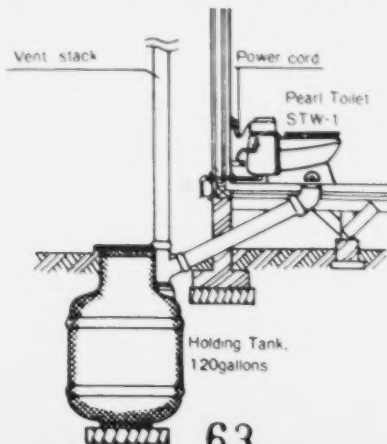
NEPON PEARL

Concept: Uses odorless, biodegradable foam to flush and clean bowl. Uses maximum of one cup of water per flush. Generally installed over a holding tank or in line with house's greywater, so that waste-carrying pipes are periodically cleared by greywater. Flush not needed for urine.

Requirements: Holding tank of 120 gallons for one toilet; larger capacity tank for additional toilets. Electricity needed to operate small air pump built into the holding tank. Water supply line not necessary; water can be hand carried. Uses same space as conventional toilet, plus area underneath for holding tank.

Service: Bowl does not need cleaning due to the detergent properties of the foam. Periodic replacement of the foaming liquid; semi-annual cleaning of the dispenser.

Operation: Bowl always filled with clean, white foam, generated by a tiny air pump. Foam moves from water tank into the bowl from several openings located in the rim, and slowly cascades down into the trap below the floor. The cascade action washes the bowl continuously, creating a slippery surface so that nothing can cling to the porcelain bowl. 30 second flush cycle uses less than one cup of water mixed with a drop of detergent. No odors; no splashing; quiet.



Model: Pearl. Available in Ivory White or Blue. Weighs 15 lbs; made of vitreous ceramic with plastic toilet seat.

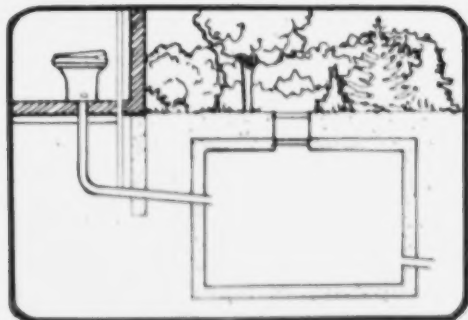
Cost: \$979 plus shipping.

Available: Water Conservation Systems, Damonmill Square, Concord, MA 01742. 1-800-343-1706.

AQUA MAGIC—THETFORD

Concept: Sealed, fresh water flushing unit that uses approximately one pint of water per flush. Fitted in the majority of trailers & motorhomes produced in North America which have onboard holding tanks. In Canada, it is also sold as a low water use toilet for cottages.

Requirements: Permanent installation with a tile drain or holding tank. Not suitable for main sewer connection. Mounts to flange in the floor and one water connection.



Operation: Single forward motion on the side-mounted lever flushes the bowl. Water level can be adjusted by operating the water fill lever.

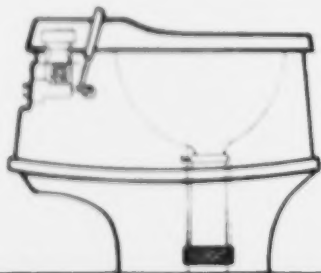
Models: Aqua-Magic IV Cottage Toilet. Available in ivory or white. Seat height is 16 3/4" or low-model with seat height of 12 1/2", where holding tank is located above the floor.

Cost: Check with plumbing or RV supply.

Available: Local plumbing or RV supply store.

SEICHE ONE—PATRICK CREEK CORP.

Concept: User determines amount of water needed to cleanse and flush the bowl — "water on demand". Average amount of water is about 1 quart per flush.



Requirements: Meets most plumbing codes and fits without modification directly on existing plumbing systems. Easy installation.

Operation: Eliminates the reservoir and the trap. A valve allows user to dispense the exact amount needed to cleanse the bowl. Then there is a straight drop to the septic system or sewer through a closed cell foam flapper valve.

Model: Unusual appearance: no tank and no foot, "the VW of toilets". ABS plastic construction.

Available: Patrick Creek Corp., P.O. Box 135, Hinesburg, VT 05461. 802/658-5656.

MANSFIELD RV & MARINE TOILET

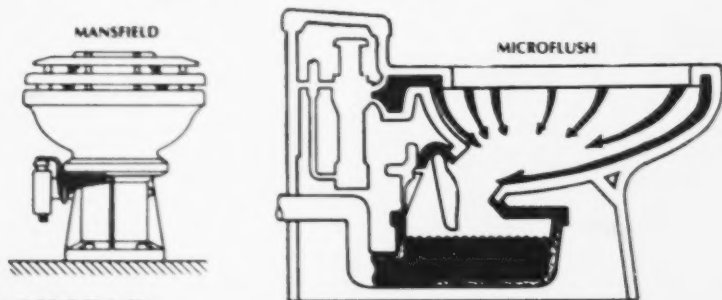
Concept: RV and marine toilets can be adapted as a low-flush home toilets, discharging into to septic tank or holding tank. Models flush with a pedal with one quart or one pint of water.

Requirements: Must have pump-out device to holding or septic tank.

Models: *Traveler 910.* RV toilet using less than 1 quart of fresh water. Comes with floor bolt package and floor seal. *Marine Traveler.* Pedal flushes with as little as one pint of water.

Cost: \$120 for *Traveler 910*;

Available: Mansfield Plumbing Products, Big Prairie, OH 44611. 216/496-3211 or at RV or marine dealers.



MICROFLUSH

Concept: Uses compressed air to discharge waste from the bowl directly into the sewer line. Provides the same water surface area and rim wash as conventional toilets, while using 2 quarts of water.

Requirements: Standard plumbing: 9" off-center water supply and 12" on-center sewage outlet. Water line out of the wall connects directly to the toilet. Uses less space than conventional toilet. No tank. Compressor is part of the unit.

Operation: When handle is pressed, the flapper valve opens, allowing the water in the bowl to flow into the lower chamber. Clean water enters from around the rim, washing the bowl. Then flapper valve closes. Clean water continues to flow into the bowl, where it remains until next flush. When flapper valve closes, compressed air is released into the lower chamber, forcing the contents out through the discharge line. There are models for either rear or downward discharge. 8-12 second flush cycle. Water pressure is 25-50 PSI; air pressure is 60 PSI.

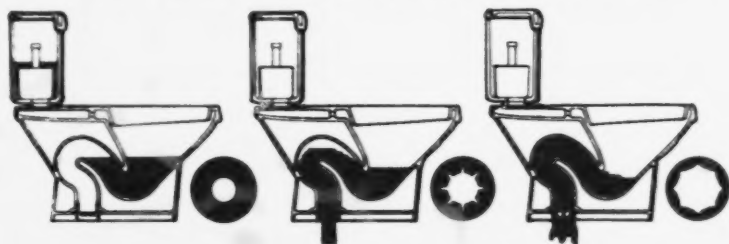
Models: Made of vitreous china and stainless steel. Elongated or round front. Contemporary colors.

Cost: Top half of price range for standard toilets.

Available: Microphor, Inc., 452 East Hill Rd., P.O. Box 490, Willits, CA 95490. 707/459-5563.

ULTRA-ONE/G-ELJER

Concept: Uses one gallon of water to flush without any additional systems. Permanently installed reservoir meters one gallon of water from the tank to the bowl and maintains a high static head of water.



Requirements: Standard plumbing. Fast, easy installation.

Operation: Same as conventional toilet.

Models: Contemporary look; fashion colors.

Cost: Same as any top-of-the-line conventional two-piece toilet.

Available: From any Eljer dealer or plumbing supply store.

IFO CASCADE

Concept: Flushes with about one gallon of water. Design conceived by Swedish sculptor Stig Carlsson to be beautiful and unusual as well as functional.

Requirements: Model 3160 fits standard American plumbing rough-in dimensions. Other models have rough-in dimensions different from standard US toilets. Uses same space as conventional toilet.

Installation: Uses existing plumbing outlets without alterations.

Models: *Model 3160 Cascade.* Designed for US standards. Uses 1.5 gallon concealed trap. Siphonic action. Quiet. *Model 3250.* Uses 4/5 gallon; visible "S" trap. Design constraints: uses ABS pipe; must ensure that individual length to "main" or septic tank is no greater than 100 feet at a slope of no less than 1/4" per foot and as straight as possible. *Model 3300.* 1.5 gallon; concealed trap. *Model 3293.* 1.5 gallon; wall-hung with built-in tank.

Cost: \$330 plus seat.

Available: Water Conservation Systems, Damonmill Square, Concord, MA 01742. 1-800-343-1706.

THETFORD SUPERINSE

Concept: Use only one gallon to flush.

Requirements: Conventional central or septic system.

Space: Same as for conventional toilet system; standard rough-in dimensions; standard flush valve & fill valve.

Model: *Superinse*. Uses one gallon of water to flush. No pumps, valves, compressors. Vitreous china bowl. Tank has anti-siphon fill valve & float, flush valve and flush lever with handle. White.

Cost: \$415 list price. Shipped freight collect. VISA, Mastercard accepted. (2/1/83 price) Shipped within 4 weeks.

Available: Thetford Corporation, P.O. Box 1285, Ann Arbor, MI 48106. 1-800-521-3032.



Water Conservation Tips

In the Bathroom:

Be sure to flush only human waste and toilet paper.

Repair toilet leaks immediately. One small leak can waste thousands of gallons each year and may only need a minute to fix.

Teach your children efficient water use habits. Take showers instead of baths. If you do take a bath, don't fill the tub so high. Use the shut off valve on your new showerhead to shut off the flow while you lather up.

Repair leaky faucets and control valves. Inspect old washers and replace if needed.

Toothbrushing and shaving don't require continuous water flow. Turn the water on only when you really need it.

In the Kitchen:

Use a plastic basin for soapy water. Rinse all dishes at once and turn off water between rinses.

Compost your kitchen scraps instead of using a garbage disposal.

Keep a bottle of drinking water in the refrigerator so you won't run the tap for cold water.

Thaw frozen foods overnight in the refrigerator or in the air instead of running hot water to thaw them.

Steam food when possible and save liquids for cooking stock.

Run only full loads in the dishwasher. Pre-clean in small basin of water.

In the Laundry:

Run only full loads in the washer; remember to use load selector.

Wash with cold water; it saves energy and gets your clothes just as clean.

In buying a new washer, get one which conserves water and has a "suds saver" which reuses the rinse water in the next wash cycle.

Outdoors

Wash your car from a bucket of suds; rinse using a hose with a restrictor spray attachment.

Mulch your garden to prevent soil drying. Water at twilight and use ground-soaking hoses instead of sprinklers.

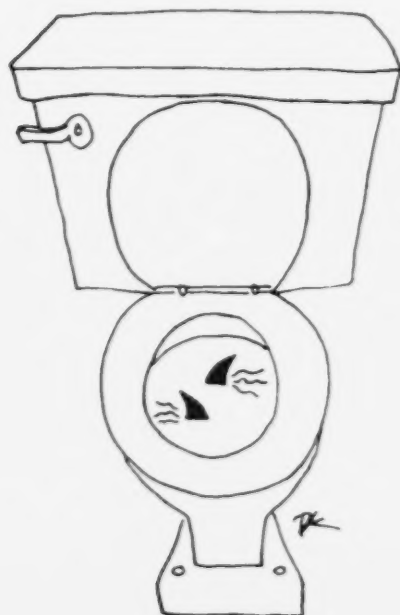
Select plants that don't need so much water. Consider using only native vegetation. Consult your local County Extension Service for advice.

Let your grass grow a bit taller, 2" or so, to save the roots and sod and to hold more dew.

Supply Sources

ECOS/Water Conservation Systems, Inc.
1 Damonmill Square
Concord, MA 01742
1-800-343-1706

Water Conservation Co-op of
Woodstock, NY
Holly Gettings, Coordinator
16 Laurel St.
Cambridge, MA 02139



MUMS THE WORD

By Evi Seidman

*Water, Oh Water
What have we done to you?
Will rain or shine
Or the sands of time
Bring back your color true?*

Water is a simple stuff
You find it everywhere
As ice or steam or
Flowing in a stream,
As snow or
Raining through the air.
As balls of hail,
As sheets of sleet,
As soft as a field of fog.
Water is a magic web
In which all of Life is caught.

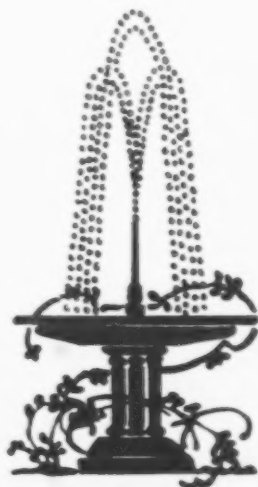
That is
Fishes, squirrels, birds & bugs,
All kinds of human beings.
Roses, weeds, and old oak trees
And people in between them.

Find one thing that ties you close
To every living thing on Earth.
As much as air,
And more than food,
We're bound by a common thirst.

Water is our common bond.
We all crawled out of the sea,
And lest we all crawl back today,
We've got a mighty mess to clean.

So comes the day
When the water's gray,
You think you'd better boil it.
Before you blame the factory,
Consider your very own toilet.

*Flush It! Oh, Flush It!
Just make it go away?
And hope you die
Before it floats by
'Cause there's no such place as Away.*



Toilet? What's a toilet?

Take a clean white bowl
A china bowl
A bowl of porcelain white
Then add enough water
To bathe a child
Yes, water that's clean and bright
Now place a seat upon the bowl
And on that seat you'll sit
And what you put in the water below
Is what we all call sh...

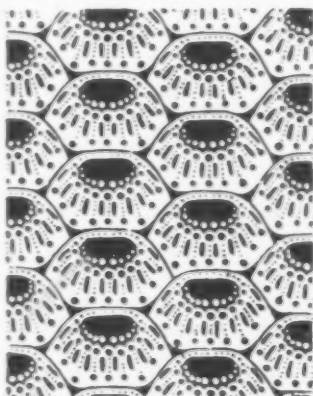
*Mums the word, mums the word
It's a nasty thing to say
So we flush it down
And we flush it out
And we try to flush it away*

Flush what? Flush what?

Your body is a factory
And what it makes is You
So the food you eat
Is the fuel you need
To do all the things you do
And what is left
That is, what's unused
That is, what we all call waste
Leaves the body out through a pipe
Which most folks never face

*Mums the word, mums the word
Is it a nasty thing we do?
Why, soil makes food
And food makes soil
Could anything be more true?*

Now a factory
Is just like me
It makes a thing or two
It uses food and uses fuel
The way our bodies do
And what is left
That is, what's unused
That is, what we all call waste
Leaves the factory
Out through a pipe
Which most folks never face



*Mums the word, mums the word
The factory does it too
We're all to blame
And isn't it a shame
That the water has lost its blue?*

So don't be mad at the factory
Or the poison that it makes
If what you put in your china bowl
Ends up in the very same place

We put it in a bowl
They inject it in a hole
We flush it down a pipe
They dump it in a stream
We treat it in a plant
They stuff it in a pit
Anyway you look at it
We're up to here in sh...

*Mums the word, mums the word
It's a nasty thing to say
So we flush it down
And we flush it out
And we try to flush it away*

The stuff that leaves the factory
And that which leaves you and me
Is food for thought
Food for the soil
And food for industry
Because what is left
That is, what's unused
That is, what we all call waste
May rightly be
A very right stuff —
We just put it in the wrong darn place!

Save It! Oh, Save It!
Don't pour money down the drain

Industry's gunk could be industry's gold
If instead of dumping it were bought and sold
It's economically sound
To cycle and salvage, recycle and then
What goes 'round, comes 'round, goes 'round again

Refine the waste!
New resources revealed!
Recycle the waste!
And the water is healed.

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You're a wizard at work
In your very own mind.
You change your ways
And I change mine
We can learn to use
What we call waste
Or get used to drinking from poison lakes

Water is Water is Water

The very first stream that was ever spoiled
(You'll take my word, I trust)
Was the One that runs in each One of us
The Stream of Consciousness

You want to heal the water?
Go back to that stream
And find the idea
That was first unclean
That water is here to carry our waste?
Our first mistake
In the very first place

Water, Oh Water
This fact remains the same:
What we put in
Is what we'll get out
In Nature's Circle Game

*Water, Oh Water
You teach a lesson true
That we all live downstream
And we live upstream
In everything we do*

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IN PRIMITIVE SOCIETY



IN MODERN SOCIETY



IN THE SOCIETY
OF THE
(not too distant)
FUTURE



Water Cleans Us



Water Supports Us



Water Refreshes Us



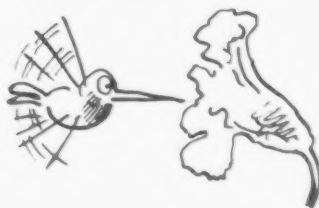
Water Reminds Us



Water Heals Us



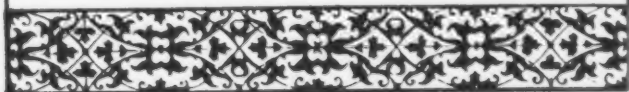
Water Nourishes Us





Behold, I will do a new thing; now it shall spring forth; shall ye know it? I will even make a way in the wilderness, and rivers in the desert. The beasts of the field shall honor me, the dragons and the owls; because I give waters in the wilderness and rivers in the desert, to give drink to my people, my chosen.

-Isaiah, 43:19-20



Water Lessons That Travel

"The water tells us we are one."

John Trudell

The need for clean, safe water spans every political and socioeconomic barrier. The water resources of a community and a nation are its heart. Any community, no matter how diverse or polarized, will eventually unite to protect its water.

The City That Water Built



Eureka Springs, Arkansas, an Ozark village of about 2,000 people, is a vivid example of the unifying power of water issues. The "City That Water Built", as it advertises itself, was a booming health spa at the turn of the century. People came by the thousands to "take the waters" of its 66 healing springs. Today, millions still come to meander along the winding streets past enshrined springs surrounded by Victorian homes and hotels.

No expense has been spared to restore the old buildings to their former elegance, but the springs are a different story. Once known worldwide as sources of some of the world's purest water, the springs have been polluted for more than half a century. Lovely wrought iron fences protect tourists from their sewage-laced water, while fountains of ordinary city water provide the illusion of naturally clean water.

Ponce de Leon's Fountain of Youth

The springs had served as gathering places for Native Americans for many centuries before they were rediscovered by a white doctor in 1881. He wrote:

I, Alva Jackson, do hereby certify that the following statement of my discovery of Eureka Springs . . . is in all particulars true and correct. About 24 years ago I was hunting bear at the head of Leatherwood. About 10 o'clock my dogs, three in number, started in and ran a panther into a hole in the cliff about thirty yards above the spring. There were large rocks in the hole that I could not get without help, so I returned home but came back next morning with my son, William, and seven others. My son had sore eyes at the time, and he complained that he did not feel like work; therefore, I advised him to wash his eyes in the Spring, for I had believed for a long time that there were some medical properties in the spring. He did so some three times during our stay at the spring. The next morning you could not have told my son ever had sore eyes. His eyes were completely cured, and this convinced me that there was medical virtue in the water. I went back the third day to further examine the spring. When I had cleaned and washed the Basin out and examined it thoroughly, I felt fully satisfied that I had found it (the Indian Healing Spring of legend). And having used and tested the water fully for twenty-four years, I am convinced, in my own mind, it is the spring spoken of by the Spanish discoverer (Ponce de Leon) of this country. I am a graduate of the Douglas Medical School of Kentucky. (signed) Alva Jackson.¹



Taking the Waters

In 1879, people began pouring into the area, following the stories of healing water. By 1882, Eureka Springs was a boomtown of 10,000 people, "some who came for healin', and some who came for stealin'". Ornate Victorian hotels and homes housed travelers who came from all of North America, even Europe, to take the waters from these springs

described as "similar to the celebrated medical springs of Wiesbad and Baden in Germany".²

Affluent and progressive, Eureka Springs was one of the first cities west of the Mississippi to pipe water into its homes and businesses. Once the convenience of running water arrived, water toilets came close behind. Soon a wastewater collection system was built to carry the water-borne wastes out of the city. But it was too little, too late.

Remember the Water

"The world's purest water" became just one more item in the long list of North American water resources lost to water-borne wastes. Epidemics of typhoid fever and similar diseases coursed through the community. Meanwhile, water cures gave way to antibiotics and immunizations.



By the 1920's, Eureka Springs was almost a ghost town. Prosperity, like pure spring water, was only a memory. At the suggestion of health officials, chlorination units were installed at several major springs to protect those faithful few who still drank their water. Later state agencies asked that city water fountains be installed at the springs. Today unsuspecting tourists fill their jugs and cups with city water while the polluted spring water is piped away to the sewers.

The city's sewer lines have lain in ruins for years. They are a sieve of broken, displaced pipes leaking sewage in all directions. Springs, creeks, lakes, groundwater and wells of the surrounding community carry spreading plumes of raw sewage. Out of every 100,000 gallons of sewage produced in Eureka Springs, more than 50,000 gallons escape before reaching the treatment facility on Leatherwood Creek, according to a 1974 engineering study.³



Water Unites; Wastewater Divides

After one false start, Eureka Springs was finally within reach of federal funds for a new wastewater treatment system in 1979. City officials were horrified when their rural neighbors mounted a well organized campaign against the plan. The people living downstream from the site for the new sewage treatment facility were indignant that city officials had chosen such a fragile spot. It was in the flood plain of Leatherwood Creek at the base of one of the continent's largest, hand-cut stone dams and in a scenic wildlife area where eagles feed.

Opponents of the site brought in old newspapers and photographs that highlighted destruction caused by the flooding creek, including bridges that had been completely washed away. Neighbors described the families of eagles that feed along the creek every year. But city officials stubbornly refused to choose a less vulnerable site.

The city's rural neighbors and their urban sympathizers organized into the community's first public eco-political group, "Concerned Citizens". They carried their cause to the media, state agencies and then

to the Environmental Protection Agency (EPA). After months of relentless effort, the suggestion percolated down to city officials to pick another spot for their new treatment facility.

Only the Beginning

Solving the site problem was only the beginning for Eureka's Concerned Citizens, now renamed the Concerned Citizens' National Water Center. With their faith in both the city's officials and its engineers shaken, more people came forward with questions about the proposed wastewater improvement project. Why use a treatment process that had failed seven times out of eight in Missouri? Why abandon the existing treatment facility when the data showed it to be large enough, and at least as efficient, as the proposed new facility? And, the most critical question of all, will this multi-million dollar project keep Eureka's sewage out of the community's water — the springs, creeks, lakes, groundwater, and wells?

The Exfiltration Study

After hearing the group, the EPA put the entire wastewater improvement project on hold. The city was given federal funds for an unprecedented program, the Exfiltration Study. Eureka Springs was to be studied in a way no U.S. city had ever been studied before.



The goal of the Exfiltration Study was to find the sources of pollution in the springs and to make a plan capable of restoring and protecting those springs. Every spring in the city was to be located and its water analyzed. Every facet of the city that affected the quality of the water in its springs was to be examined under the spotlight of a full scale public participation program.^{4,5}

Always important in Eureka Springs, water became the hottest political topic in town in 1980. A slate of candidates for the City Council campaigned and won with their "clean water" platform. They promised to adopt a wastewater improvement plan that would restore the city's springs by repairing all of the leaking sewer lines and renovating the existing wastewater treatment facility. Concerned Citizens' National Water Center was by now a depository of information and expertise on water issues.

The new City Council hired the staff of the National Water Center to coordinate the public participation program and act as liaison to the scientists involved in the Exfiltration Study. Despite a long list of oversights, errors and misjudgements, the Council renewed its contract with the same engineering company, one of Arkansas' most prestigious con-

sulting firms. Any change would delay EPA approval and jeopardize funding for the wastewater project.

Public Participation Program

The Water Center team coordinated one of the most extensive public participation programs ever carried out in EPA Region VI. Every week they met with the 16-member Citizens' Advisory Committee (CAC). Members were appointed by the City Council according to EPA guidelines. They wrote and distributed detailed reports of each meeting to over 50 people within the city, state agencies, EPA Region VI office and regional news media. The CAC reports covered the concerns, suggestions and projected agendas of the public participation group. The three coordinators worked with the Exfiltration Study scientists, assisting them with their work in the community and carrying their progress reports to the CAC each week.

Combining city records, the Center staff established annual and seasonal patterns of water use and determined water loss from leaks in the water distribution system. Water users were categorized to establish the basis for an equitable water/sewer charge system.

Local citizens were hired and trained by the Water Center staff to carry out special tasks within the Exfiltration Study:

1. Teams of Eurekaans, one adult with one high school student, conducted a house-to-house survey to document water use patterns, use of water-conserving devices and practices, familiarity with recycling and alternative waste treatment, etc. According to the survey results, 25 per cent of the city's water/sewer customers were interested in making the transition to appropriate on-site waste systems, such as composters.⁶

2. Other surveyors located springs, water and sewer lines, service lines, septic tank/leach fields, sewer leaks, etc. They documented that 59,443 feet of the city's 60,000 feet of sewers were leaking and that 147 septic tank/leach fields were within the city limits. A survey of city plumbers indicated that at least 50 per cent of the 42,000 feet of privately owned service lines were leaking. All of this information was mapped on enlarged aerial photos of the city along with color-coding for each structure in the city according to its use.⁷

3. The city's tourists were profiled by a third team of surveyors. They collected data on visitor ages, education, income, length of stay, reasons for coming, amount of money spent, etc. This information provided the basis for projected water, waste and wastewater management needs. Survey results emphasized the need to spend more of the city's tourist tax revenues on services rather than advertising and promotion, since most of the visitors were drawn by word-of-mouth recommendations.⁸

All in all, Eureka Springs was measured right side up, upside down and crossways. Every physical aspect of the town was examined, mapped and quantified as accurately as possible.

In addition to coordinating these efforts, the Water Center team gathered information from numerous sources on water conservation, waste reduction, conventional wastewater treatment, wastewater restoration and dry treatment for domestic wastes. This information was sifted, distilled and disseminated to the community, city officials, the city's

engineering firm, the Arkansas Department of Pollution Control and Ecology, the Arkansas Department of Health, and the EPA Region VI offices. This was done through the weekly CAC meeting reports and progress reports from the Exfiltration Study.

The Choice: Clean Water or Wastewater

As the work progressed, it became apparent that a conventional wastewater collection will never keep the city's sewage out of the springs and other water resources. The geology alone presents an insurmountable obstacle. The thin, rocky soil is constantly sliding down the sides of the steep, rugged hills. Meanwhile water (rainwater, groundwater, escaping city water and raw sewage) dissolves the limestone bedrock. This forms channels, pits and sinkholes. A network of sewer pipes buried in this terrain is certain to be dismembered and ground to shards. Even the small-diameter metal and plastic system that carries water to Eureka's homes routinely leaks 30-50 per cent of the water piped through it despite the efforts of city crews to keep it repaired.

Neither the EPA, the state nor the city of Eureka Springs is willing to pay for a central wastewater *restoration* facility, a plant with the ability to discharge clean water. A standard central wastewater treatment system dooms all of the downstream water sources to a state of perpetual pollution — Leatherwood Creek, the aquifer it feeds, the wells that tap into that aquifer, and Table Rock Lake. And no one, not even the state agencies, believes that septic tank/leach fields are a suitable on-site approach in this soil-poor region.



Ignoring the evidence and repeated CAC requests, the city's engineering firm refused to provide cost estimates for appropriate on-site alternatives. As the case for profound changes in the city's wastewater improvement facility plan grew stronger, city officials and engineers grew less cooperative with the Water Center team. By late summer of 1981, the Center staff were evicted from their City Hall office with their files impounded and their salaries withheld.

CAC Findings & Conclusions — Decentralize!

Despite these difficulties, the Water Center team continued working on the project until the CAC's final recommendations were completed in January, 1982. The *Findings and Conclusions of the Citizens' Advisory Committee* offered a wastewater improvement plan designed to keep the city's wastes out of water resources for the least cost. The 16-member, publicly-appointed committee found that "terrain-sensitive, on-site treatment offers the most economical means of meeting the community's need for good waste/water management. This decentralized approach also provides the best protection for the groundwater and springs".⁹

The CAC suggested a gradual transition with appropriate on-site systems installed first where septic tank/leach fields are in use, in all new construction, and at those homes and businesses being renovated. Then, moving inward from the outskirts of the city, homes in neighborhoods with leaking sewer lines would be retrofitted with on-site systems. Renovating the city's wastewater plant, budgeted for under \$900,000, and repairing the sewer lines in the denser core of the town would improve this outgoing system's performance during the transition.

Composters and greywater systems, both of which are eligible for EPA funding at the highest rate, and low-flush toilets with holding tanks were among the appropriate on-site systems found to be best suited to the geological conditions in Eureka Springs. The CAC also recommended strong water conservation codes for the city, and a waste/water management board to supervise the installation and operation of the on-site systems and carry out a continuing public education program.

The CAC's recommendations were presented to the Eureka Springs City Council in January, 1982. At the same meeting, the city's engineering firm also offered their final wastewater improvement facility. This plan was supposed to reflect the findings of the Exfiltration Study and the recommendations of the CAC. The engineers' proposal consisted of a \$2.1 million upgrade of the wastewater plant and repair or replacement of 10,000 feet of leaking sewer lines. The CAC's suggestions for a water conservation program and a waste management body were incorporated. However, the only recognition of the CAC's overall recommendation — decentralization — was a "waste reduction" program, a pilot project of 100 composters.¹⁰

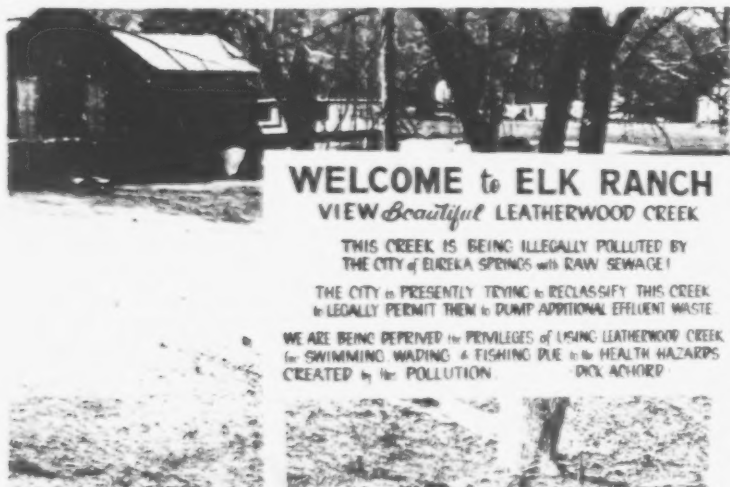
Faced with an immediate funding deadline, the Council rushed to approve the engineering firm's facility plan despite its failure to provide a solution to the water pollution problems. They did, however, honor their campaign promise by insisting that the final plan include 100 per cent repair or replacement of the sewer system.

This compromise plan was submitted immediately to the Arkansas Department of Pollution Control and Ecology (ADPC&E) which approved the \$2.1 million renovation of the wastewater treatment facility. However, the agency approved the repair or replacement of only 10,000 feet of the 59,443 feet of leaking sewer lines. They refused to fund the pilot project of composters. The final cost estimates for the project totalled over \$3 million.

Leatherwood Creek Reclassification

In 1983, a move was made to reduce the cost of renovating the treatment facility. On the advice of ADPC&E itself, the city's newly-elected mayor and city council petitioned ADPC&E to classify Leatherwood Creek, the receiving stream for the city's treated wastewater, as "effluent-dominated". This would lower water quality standards for the creek so the city could spend less on upgrading the treatment process.

Once again the people who live downstream from Eureka Springs mobilized to protect their water. A series of heated confrontations generated publicity but no resolution. After the determined downstream families filed a law suit, city officials finally withdrew their petition to lower standards for the creek.



In late summer 1985, Department of Health workers poured fluorescent dye into Leatherwood Creek at the wastewater plant discharge site. The downstream families found green-dyed water coming out of their faucets.¹¹ It is certain that as long as Eureka Springs has a conventional centralized wastewater treatment system, their wells will be contaminated by the treated sewage discharged by the treatment facility and raw sewage from broken sewer lines.

The Present

Now in the fall of 1985 the renovation of the wastewater treatment plant has begun. There is no sign of funds or plans for the waste management board, water conservation program, repair or replacement of the remaining 50,000 feet of leaking sewer lines, elimination of 147 unsuitable septic tank/leach fields or the pilot project of composters.

By providing funds only for the improvements in the centralized system, the EPA and ADPC&E have added to, not solved, Eureka Springs' water pollution problems. Wastewater flows will increase dramatically as soon as the plant renovation is completed. At that time, the Department of Health has promised to lift the building moratorium imposed on the city several years ago. City officials already have a long list of construction projects on hold, waiting for the ban to end.

By the end of 1986, Eureka Springs will have an upgraded, but inadequate wastewater treatment system, an enormous debt, still polluted water resources, plus a continued vulnerability to law suits from downstream neighbors. But from another point of view, the groundwork for the transition to a decentralized system of appropriate on-site treatment has been well laid. With the wastewater treatment plant upgraded, the core sewer lines repaired, and the highly detailed mapping of the city, the remaining steps to decentralization, as outlined by the CAC, are only waiting to be taken.

The Future: A Vision of Clean Water

Eureka Springs, Arkansas, "The City That Water Built", can still become "The City That Saved Its Springs". By proceeding with the decentralization to appropriate on-site systems, Eureka Springs can lead the way for other North American communities who want to protect their water resources.

The people of Eureka Springs are as diverse as a cross-section of the population of the continent: native hill folk, Chicago retirees, New York authors, Kansas City entrepreneurs, artists, musicians, and business people from around the world. Yet, with all of their differences, almost every one of them will admit to sharing the dream of restoring the springs. Four years ago, at least one-fourth of Eureka's households were interested in changing to appropriate on-site waste systems to keep their wastes out of the springs. Today, that number would be even larger.

Without government funds, and sometimes without government approval, people in and around Eureka Springs and many other communities in North America are taking charge of keeping their own wastes out of their water resources. Building and buying composters and greywater systems for their homes and businesses, they have already begun the "Toilet Revolution" — the beginning of the end of the water crisis!



About The Water Center

In seven years TheWater Center has grown from a group of people trying to solve local water problems to a familiar voice in the mid-South, particularly in Arkansas, Missouri and Oklahoma. Center staff regularly review and comment on state and federal actions that affect water quality. The four-hour drive to Little Rock to speak at public hearings and meet with officials at the Arkansas Department of Pollution Control and Ecology, the Arkansas Department of Health, the Governor's Office, and other state agencies has become a frequent and familiar journey.

After years of persistent efforts by TheWater Center, other individuals and groups, Arkansas state agencies now approve composters on a case-by-case basis. One of the Center's major continuing projects is working for approval and funding for an urban pilot project of appropriate on-site waste treatment systems.

In its first years, the Center was staffed entirely by unpaid volunteers with its operating expenses paid by donations and dues. In 1984, funding by a private foundation expanded and intensified the "waterwork". With three half-time paid staff members, an office and resource center, the Water Center has sponsored three conferences and five National Water Weeks, produced and aired three videodocumentaries and one album of water music, and written numerous articles, news releases and newsletters on water issues. Center staff have spoken, performed and participated in conferences, meetings and festivals across the continent — spreading the message that clean water is a personal right AND a personal responsibility.

In 1980, the Water Center initiated the first National Water Week as a way to increase public awareness of the need for protecting water resources. In the small town of Eureka Springs, more than 150 people contribute their time and energy every year to produce this celebration of water during the week of the autumnal equinox. This weeklong series of events — swim meets, canoe and pontoon boat floats, workshops, art shows, movies, music, comedy and dance — can be adapted for any community. Hopefully, one year every community will remember their life-base water resources with a Water Week.



In honor of Ellen Swallow Richards, the woman who founded ecology, the Water Center sponsored the first Ellen Swallow Richards Retreat and Award in 1985. This annual event is held near her birthday in early December. The Retreat offers the opportunity to recognize individuals who have made major contributions to water resource protection and to gather waterworkers from all areas of the continent to share information and mutual support.



WaterWorkers Unite! (Foreground, left to right) Holly Gettings, Carolyn Green, Lea Foushee, Jacqueline Froelich. (Background) Cecille Morin, Pat Costner, Barbara Harmony.

Another major Water Center project has been the production of the audiocassette album, *We All Live Downstream — Songs for Living Water*. This collection of ten water songs was composed and performed by musicians from the Eureka Springs community. This album, "We All Live Downstream" tee-shirts, bumper stickers, stationery and postcards are part of The Water Center's effort to support its waterwork.

The Water Center is serving as a clearinghouse for information on appropriate on-site treatment for domestic wastes. Please send information about your experiences with these alternative systems and your concepts, plans, adaptations, and suggestions to: **The Water Center, P.O. Box 548, Eureka Springs, AR 72632. 501/253-9755.**

**"Remember
the Water..."**

Water Center Proclamation

As the air is the living breath of our planet and the trees are its breathing, the Earth's waters are its living blood, coursing through its streams with a flow as vital to us as the blood running in our veins...

Through all our lives, the waters have sustained, nurtured and healed our bodies and spirits; in return for this gift we have defiled the waters with our poisons and wastes; we have violated the natural order and law followed by all other living things of the land; the law being that the gifts of the land, the nutrients in the food that pass through our bodies to become what we call "waste" be returned to nourish the land. To use the waters as a carrier and dump for "waste" nutrients is a deep wrong which impoverishes the land, and brings sickness both to water and to us as we participate in this injustice.

Since human "waste" must become a nutrient on the land, not a pollutant of the waters, we must realize that though we continually strive to develop new technologies to deal with our problems, the greatest innovation is conservation. As we conserve precious water, we can also conserve and enrich our soil through the recovery of human "waste"...

All over the Earth the rivers, lakes and oceans have struggled to cleanse themselves of our thankless waste, but can do so no longer by themselves; while we still have the measure of grace and health they have given to us by their struggle, we must join them to conserve, protect and HEAL THE WATERS...

Therefore, let us establish an annual "Water Week" to be held each year at the autumnal equinox to celebrate and cherish the waters of our Earth, and to rededicate ourselves to the protection of those waters.

Heal
the Waters!



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Resources

National Coalition Against Mass-Burn Incinerators
82 Judson Street
Canton, NY 13617

National Network to Prevent Birth Defects
c/o NCAMP
530 7th Street, S.E.
Washington, DC 20003

Re:Sources Bulletin
1346 Connecticut Avenue, S.W., Suite 912
Washington, DC 20036

The Workbook
Southwest Research and Information Center
P.O. Box 4524
Albuquerque, NM 87106

Environmental Action
1525 New Hampshire Avenue, N.W.
Washington, DC 20036

Everyone's Backyard
Citizen's Clearinghouse for Hazardous Wastes, Inc.
P.O. Box 926
Arlington, VA 22216

U.S. Water News
230 Main Street
Halstead, KS 67056

FOCUS
Hazardous Materials Control Research Institute
9300 Columbia Boulevard
Silver Spring, MD 20910

RAIN
Center for Urban Education
3116 North Williams
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Lewis Regenstein, author of the Pulitzer Prize-nominee *America the Poisoned: How Deadly Chemicals Are Destroying Our Wildlife, Our Environment — and Ourselves* and *The Politics of Extinction*, is Vice President of The Fund for Animals.